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**U.S. Army
Environmental
Center**

**FORT DEVENS
COLD SPRING BROOK
SITE INVESTIGATION**

**FINAL
COLD SPRING BROOK SITE INVESTIGATION
WORK PLAN
DATA ITEM A004**

CONTRACT DAAA15-91-D-0008

**U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MARYLAND**

NOVEMBER 1994

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TASK ORDER NUMBER 0004**

Prepared for:

**U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland**

Prepared by:

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Wakefield, MA
Project No. 07005-01**

NOVEMBER 1994

**COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MASSACHUSETTS**

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FORT DEVENS, MASSACHUSETTS**

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1.0 INTRODUCTION

Cold Spring Brook is a perennial stream located along the eastern boundary of the Main Post at Fort Devens (Figure 1). The brook receives water in the form of runoff and storm drainage from several land use areas. Investigations have been performed in and around Cold Spring Brook to characterize the distribution and continuing contributions of contaminants in the brook. Several storm drain outfalls that drain industrial areas along Barnum Road have been identified as potential contributors to contamination in the brook. The objective of this site investigation (SI) is to provide a more detailed evaluation of the distribution of contaminants in Cold Spring Brook and their effects on ecological receptors.

This work plan establishes the background, rationale, and plans for the continued investigation of Cold Spring Brook.

1.1 PURPOSE AND SCOPE

The purpose of the Cold Spring Brook SI is to collect information on the distribution of contaminants in surface water and sediment at the storm water outfalls, and in the floodplain and stream channel of Cold Spring Brook, and to evaluate any ecological risks posed by surface water and sediment contamination. In addition to Cold Spring Brook, this investigation includes a limited evaluation of a storm water outfall that discharges from the Barnum Road industrial area to Grove Pond.

Because previous studies have shown that contaminant concentrations are not significant in surface water and sediment in areas immediately upstream of the industrial area, this investigation focuses on the Barnum Road industrial area. The data gathered during this investigation will be combined with earlier investigation results to identify point and non-point contaminant sources historically and currently impacting Cold Spring Brook and the associated floodplain. The results of the ecological effects evaluation will be considered during development of recommendations for possible future actions.

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1.2 SITE DESCRIPTION

The southern section of Cold Spring Brook collects runoff from the magazine area and the Cold Spring Brook landfill (see Figure 1). Further downstream, it flows north through woodlands and wetlands and passes beneath the Boston & Maine Railroad (B&MRR) right-of-way at Barnum Road. From there, the brook collects runoff from the industrial area along Barnum Road as it flows northeast off Fort Devens property (Figure 2). The brook ultimately discharges to Grove Pond.

The Cold Spring Brook floodplain is a forested swamp habitat dominated by red maples (*Acer rubrum*). Various oak species (*Quercus* spp.), grey birch (*Betula populifolia*), white pine (*Pinus strobus*), silky dogwood (*Cornus amomum*), sheep laurel (*Kalmia angustifolia*), swamp azalea (*Rhododendron viscosum*), highbush blueberry (*Vaccinium corymbosum*), and speckled alder (*Alnus rugosa*) also occur in the floodplain of Cold Spring Brook. Typical floodplain herbaceous components include various graminoids, cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), and sphagnum mosses (*Sphagnum* sp.). Common reeds (*Phragmites australis*), and cattail (*Typha latifolia*) grow in several of the storm drain outfall areas at Cold Spring Brook.

Cold Spring Brook includes slow-moving (lentic) environments, typically behind man-made dams, as well as channelized regions with more lotic characteristics.

1.3 SUMMARY OF PREVIOUS INVESTIGATIONS

Several surface water and sediment sample pairs were collected in Cold Spring Brook and the associated storm drain outfalls as part of the 1992 Group 3 Study Areas (SAs) SI and the 1993 Study Area 57 SI (ABB Environmental Services, Inc. [ABB-ES], 1993a and ABB-ES, 1993b; respectively). In 1993, the storm drain systems of Cold Spring Brook were investigated as part of the Base Realignment and Closure Environmental Evaluation (ADL, 1994). These and other storm drain systems were collectively designated as Area Requiring Environmental Evaluation (AREE) 70. The AREE 70 evaluation was designed to identify potential sources of contamination that were not identified through previous investigations. Each storm drain system network was assessed to identify the areas (e.g., parking lots and floor drains) contributing storm water to Cold Spring Brook.

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Based on the contaminant concentration statistical trends observed at the outfalls and in Cold Spring Brook, several storm drain systems were identified for further evaluation in an Arthur D. Little report entitled *Final Storm Sewer System Evaluation (AREE 70) Report* (ADL, 1994). Appendix A presents information from the A.D. Little report. Storm Drain Systems No. 1, 2, 3, 6, and 7 were identified as systems of concern based upon analytical results. A summary of the results of this report follows. Sampling locations are illustrated in Figure 3.

Storm Drain Systems No. 1 and No. 2. System No. 1 drains an area located to the west of Building 3769 (the Armory) just south of Barnum Gate on Barnum Road. System No. 1 discharges from a headwall just east of Barnum Road into a drainage swale that runs southeast and discharges to Cold Spring Brook. The eastern half of System No. 2, which empties into the same drainage swale as System No. 1, drains a small area on the eastern side of Barnum Road adjacent to System No. 1. Aerial photographs from 1943 indicate that the area west of Building 3769 was once occupied by a large rail yard. From 1952 to the present, the area has been used for vehicle storage. The entire area is currently occupied by the Massachusetts Army National Guard. There are no AREEs or SAs associated with System No. 1. Barnum Road is the only land use associated with the drainage area of System No. 2. There are no AREEs or SAs associated with System No. 2.

Three semivolatile organic compounds (SVOCs) found during previous investigations were selected as target analytes in sediment: anthracene, fluoranthene, and pyrene. Copper and lead were also found at elevated concentrations, and are considered target analytes. The presence of SVOCs and inorganics is consistent with the drainage area's vehicle storage use.

Storm Drain Systems No. 2 and No. 3. System No. 3 and the western half of System No. 2 were evaluated concurrently because the two systems discharge to the same headwall location. System No. 3 is a system that drains a large area around Building 259, a vehicle maintenance shop occupied by the Massachusetts Army National Guard. Runoff is collected from this area and from land to the west of Barnum Road where large lots are used for vehicle storage. The runoff flows southeast under Barnum Road and is discharged through a headwall into a drainage swale that leads to Cold Spring Brook. This swale also accepts flow from System No. 4 which discharges from a headwall further up-slope.

Based on previous investigations, two SVOCs in sediment, fluoranthene and pyrene, and arsenic (an inorganic) in surface water were selected as target

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analytes for System No. 2. System No. 3 had several elevated analyte concentrations in sediment, including chromium, vanadium, tetrachloroethylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene. Lead was identified as a target contaminant in surface water at System No. 3. Elevated concentrations of 2-methylphenol, 4-methylphenol, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene were detected in System No. 3 sediment. The presence of inorganics and SVOCs in Systems No. 2 and No. 3 is consistent with roadway runoff and the area's historical land use as vehicle repair shops and storage yards since 1943.

Storm Drain System No. 5. System No. 5 collects storm water drained from the western section of the land occupied by the Massachusetts Army National Guard to the west of Barnum Road, near Buildings 3702 and 3703, and from paved areas around these buildings. The collected runoff flows northeast under the road leading to Grove Pond and discharges into a wooded area on the southeast side of Grove Pond. The presence of metals (arsenic, beryllium, cobalt, chromium, nickel, and vanadium) and the SVOC pyrene in sediment detected during the AREE 70 investigation is consistent with the area's historical land use as motor pools, vehicle repair shops, and vehicle storage yards since 1943.

Storm Drain System No. 6. System No. 6 collects runoff from the area around Buildings 3712 and 3713, an area that includes vehicle storage areas and a portion of unpaved railroad track. The system initially drains to the southwest, but turns to the southeast before passing under Barnum Road and discharging into a drainage swale that leads to Cold Spring Brook. As interpreted from aerial photographs, historical land use near System No. 6 includes a former commissary and vehicle storage/maintenance facility. During the SA 57 investigation, it was determined that System No. 6 received a spill of approximately 3,000 gallons of No. 4 fuel oil from an overfilled underground storage tank in 1978. The old commissary (Building 3712) is currently leased to the B&MRR. The AREEs and SAs associated with System No. 6 are 61X, 61AA, 69AN, 69AT, 69AS, SA 38, and SA 57.

During previous investigations of System No. 6, arsenic, chromium, and lead were found in sediment samples, and arsenic and lead were found in surface water samples. Samples from System No. 6 also contained the highest concentration of tin in sediment detected during the AREE 70 investigation of Cold Spring Brook. The presence of metals in System No. 6 is consistent with the vehicle storage and maintenance facility and the railway and trucking operations occurring in the

drainage area. System No. 6 also carried the discharge of a fuel spill associated with SA 57 Area 1 and the floor drain at SA 38.

Storm Drain System No. 7. System No. 7 drains a small wooded area located south of System No. 6 near Barnum Road and Cold Spring Brook. The system flows to the east, under Barnum Road, and then into a drainage swale that leads to Cold Spring Brook. Historical land use near System No. 7 includes a driver training facility to the northwest. Railroad tracks lie to the west. There are no AREEs or SAs associated with this system.

During previous sampling, System No. 7 showed elevated concentrations of several analytes (arsenic, barium, beryllium, cobalt, and nickel) in sediment. The system also contains the highest concentration of manganese and sodium detected in Cold Spring Brook sediments. The metals observed in System No. 7 are not consistent with known historical land use in the area, which is predominantly open space.

SA 57/Area 2 In addition to the storm drain outfalls, Area 2 of SA 57 has been identified as a potential source of contaminants to Cold Spring Brook. During the Groups 2 & 7 SI, the investigation of Area 2 revealed petroleum-related contaminants (notably naphthalene and total petroleum hydrocarbons) in surface soil collected from a drainage swale that leads to Cold Spring Brook. The swale meets Cold Spring Brook downstream of the System No. 6 drainage swale, just upstream of the containment dam installed during the 1978 No. 4 fuel oil recovery effort (Figure 3). It was concluded that the contaminants discovered in the Area 2 swale (most likely from crank-case oil) were related to past maintenance of military equipment stored nearby. Evidence suggests that these contaminants have migrated downslope toward Cold Spring Brook and represent a potential source of brook contaminants.

Bowers Brook The Bowers Brook watershed is considered an additional source of contaminants to Cold Spring Brook from off-site agricultural activities. Bowers Brook enters Cold Spring Brook from the west downstream of the No. 4 fuel oil containment dam and SA 57 Area 2.

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1.4 DATA NEEDS

No clear correlation between most of the contaminant concentrations found in the outfalls and the contaminant concentrations found in Cold Spring Brook was observed in the data obtained during the AREE 70 investigation (Appendix A). There may be a positive correlation, however, between elevated concentrations of metals and SVOCs in the outfall location and the stream sample location at System No. 3. With this exception, one can only infer from the current data that the outfalls are the single or primary source of the contamination detected in Cold Spring Brook. Analyte concentrations, in general, increase downstream from the confluence of the System No. 7 drainage swale and Cold Spring Brook, which corresponds to the general location of the Fort Devens industrial area. There may be additional non-point sources contributing to the contamination in Cold Spring Brook, but the storm system outfalls are the most likely sources. Variability in natural geochemistry within the sediment areas sampled at the outfalls and in Cold Spring Brook may also have contributed to data variability.

The proposed sampling and evaluation activities have been designed to further characterize the distribution of contaminants associated with both storm system and non-point source releases, as well as to evaluate the overall ecological effects of the contaminants on Cold Spring Brook.

The following sampling and evaluation activities are proposed to establish baseline conditions, confirm sources, and evaluate potential effects of exposure to contaminated surface water and sediments from the industrial areas along Barnum Road that have been identified as potential contributors to contamination in Cold Spring Brook:

- Measuring concentrations of contaminants in Cold Spring Brook sediment and surface water at locations selected based on previous sampling results
- Measuring concentrations of contaminants in storm water outfall drainage ditch sediment and surface water
- Conducting an ecological characterization of the floodplain community at Cold Spring Brook
- Conducting a sediment toxicity testing program on sediment samples from Cold Spring Brook

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- Performing a semi-quantitative macroinvertebrate study at Cold Spring Brook
- Conducting an ecological risk characterization

Specific methods and procedures to be used in each of these tasks are discussed in Section 3.

2.0 GENERAL FIELD INVESTIGATION TASKS

This section describes the general tasks necessary to undertake and complete the site-specific tasks set forth in Section 3. The tasks proceed from planning, through field and laboratory work, and data evaluation.

2.1 PROJECT PLANS

Project planning begins prior to beginning field investigation work, and continues throughout the project in response to changing conditions and preliminary data interpretation.

Detailed discussions of relevant requirements, methods, and procedures are presented in this Work Plan and separately in the ABB-ES Fort Devens Project Operations Plan (POP), which includes elements of the Field Sampling Plan (FSP), the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) (ABB-ES, 1993c). The POP is a working document that is revised as ABB-ES procedures change and emerging health and safety issues are addressed.

With the exception of detailed investigation-specific activities, the POP includes the QAPP and elements of the FSP. The POP presents detailed descriptions and discussions of the following elements:

- Project Organization and Responsibilities
- Quality Assurance (QA) Objectives for Measurement
- General Sampling Procedures
- Sample Handling and Custody Procedures
- Equipment Calibration and Preventive Maintenance
- Analytical Procedures
- Data Management
- Internal Quality Control (QC)
- QA Activities
- Problem Prevention
- Data Assessment Procedures
- Corrective Actions
- Reports
- Site-Specific HASP

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2.2 DATA QUALITY OBJECTIVES

The levels of data quality, U.S. Army Environmental Center (USAEC) Certification Classes, and Data Quality Objectives (DQOs) for the project are specified in Volume I, Subsection 3.2 of the POP.

2.3 FIELD INVESTIGATIONS

The field investigation will include sampling of surface water and sediment at several locations in Cold Spring Brook to characterize surface water and bulk sediment contaminant concentrations, and evaluate effects on ecological receptors. Fieldwork will be conducted in accordance with the procedures specifically identified in Volume I, Section 4.0 of the POP, or this Work Plan.

2.4 LABORATORY ANALYTICAL PROGRAM

The laboratory analytical program is designed to measure the concentration of organic and inorganic target analytes in surface water and bulk sediment. Specifically, the laboratory analytical program for Cold Spring Brook includes the Project Analyte List (PAL) SVOCs, PAL pesticides and polychlorinated biphenyls (PCBs), PAL inorganics, total organic carbon (TOC), water quality parameters, total suspended solids (TSS), grain size distribution, and percent solids. Off-site laboratory analytical procedures are presented in Volume 1, Section 7.0 of the POP (ABB-ES, 1993c). The laboratory QA Plan and USAEC Performance Demonstrated Methods are presented in Volume II of the POP, Appendices B and C, respectively.

2.5 QUALITY ASSURANCE/QUALITY CONTROL

Environmental sampling and analysis will be conducted in accordance with requirements of the USAEC QA Program (USATHAMA, 1990) and the POP. Details of the collection procedures and frequency of the QC samples are provided in Volume I, Section 9.0 of the POP.

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2.6 DATA MANAGEMENT

Geotechnical, biological, and chemical data generated as part of these field investigations will be managed in accordance with applicable USAEC data management procedures (discussed in Volume I, Section 8.0 of the POP). Data for this project will include the results of chemical analyses of biological and sediment samples, as well as the results of the sediment toxicity test program.

3.0 SITE SPECIFIC SAMPLING ACTIVITIES

The section discusses the specific methods and procedures to be used in site investigation activities at Cold Spring Brook. Tables 1 and 2 summarize proposed sampling activities and rationale. Figure 3 depicts proposed (as well as existing) sampling locations and bioassessment stations.

3.1 ECOLOGICAL CHARACTERIZATION

A qualitative ecological investigation will be conducted to identify potential ecological receptors and exposure pathways in Cold Spring Brook. The ecological survey will qualitatively characterize the ecological communities associated with the Cold Spring Brook floodplain in the vicinity of Storm Drain Systems No. 1, 2, 3, 6, and 7, SA 57 Area 2, Bowers Brook at its junction with Cold Spring Brook, and Grove Pond in the vicinity of Storm Drain System No. 5.

Ecological receptors in the vicinity of Cold Spring Brook, and Grove Pond (in the vicinity of the Storm Drain System No. 5 drainage swale) which potentially could be exposed to contaminated environmental media will be identified. Possible site-specific exposure pathways through which ecological receptors could be exposed to contaminated media will be evaluated, and biological receptors at the site will be observed for gross signs and symptoms of stress. The qualitative ecological survey will help further define the proposed surface water and sediment sampling locations, and define sampling requirements for the macroinvertebrate study. This survey includes a limited literature review and a limited field reconnaissance program as described below.

A limited literature review will be conducted to evaluate the major floral and faunal receptors and ecological community types likely to be encountered in the Cold Spring Brook floodplain. Existing information sources related to flora, fauna, and ecological communities in the area will be reviewed, and standard taxonomic sources and references will be identified. Trustee agencies such as the U.S. Fish and Wildlife Service, the Massachusetts Division of Fish and Wildlife, the Fort Devens Forestry Department, and the Massachusetts Natural Heritage Program will be contacted for information regarding state or federally listed endangered or threatened species. Historic information on the biota (e.g., fish) of Cold Spring Brook will be retrieved.

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Following the information review, a limited field reconnaissance program will be initiated to characterize the aquatic, wetland, and terrestrial habitats at and in the vicinity of the Cold Spring Brook floodplain in the vicinity of Storm Drain Systems No. 1, 2, 3, 6, and 7, and at Grove Pond in the vicinity of Storm Drain System No. 5. The field program will identify and verify major vegetative cover types and dominant taxa along the storm system drainage swales near Cold Spring Brook. This field program will involve a site walk-over by a wetland-aquatic specialist and an ecologist. Limited habitat mapping will be completed. Observed evidence of ecological stress in plant species, such as yellowing, wilting, or insect infestations, and animal species (disease, parasitism, death, and reduced diversity or abundance) will be noted. The field reconnaissance program will be conducted in the fall of 1994, or in the spring of 1995 if it appears that seasonal leaf coloration and leaf-fall may mask ecological stress. Any state or federally listed rare or endangered species identified during the survey will be documented.

3.2 SURFACE WATER AND SEDIMENT SAMPLING

The primary objective of the surface water and sediment sampling program in Cold Spring Brook and the associated storm systems is to characterize further the sources and extent of contamination in the stream and floodplain. Information derived from the proposed surface water and sediment sampling program at Cold Spring Brook may be used to evaluate risks to ecological and human receptors, to help derive Preliminary Remedial Goals (PRGs) and/or target cleanup levels for contaminated sediments within Cold Spring Brook and its floodplain, and to help evaluate alternatives.

Proposed sediment sampling and analysis activities include collection of sediment samples from 20 locations established in Cold Spring Brook, and 16 locations in the floodplain drainage swales or other potential sources (see Figure 3). The 16 locations include two samples from Storm Drain System No. 5, which drains toward Grove Pond. Based on the previous work in Cold Spring Brook, general locations were selected to characterize contaminant distributions along drainage pathways from culverts in the floodplain, and in depositional areas up- and downstream of the drainage pathways leading to Cold Spring Brook. The lotic and lentic nature of the brook was also considered in the selection of brook sampling locations. Upstream reference and downstream recovery sampling locations have been selected to assess sediment and surface water conditions up- and downstream of the Barnum Road industrial use area. The specific rationale for each sampling location is provided in Table 2.

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Actual sampling stations will be selected for areas of special interest based on information gathered during the qualitative ecological characterization (Subsection 3.1) and obvious areas of sediment or organic matter deposition. Sampling locations will be marked temporarily with stakes or surveyor's flagging and later surveyed by a Massachusetts registered land surveyor (to the extent practical given the physical access limitations) or located by a Global Positioning System. Water depths, stream width, and flow velocity will be noted at each surface water and sediment sampling station.

Surface water and shallow sediment samples will be collected in accordance with Volume I, Subsection 4.5.3, of the POP (ABB-ES, 1993c). Surface water samples will be analyzed for PAL SVOCs, pesticides and PCBs (at bioassay stations only), total and dissolved inorganics, and the water quality parameters TSS, chloride, sulfate, total hardness, and alkalinity (Table 3). Sediment samples will be analyzed for PAL SVOCs, pesticides and PCBs (at bioassay stations only), PAL inorganics, TOC, total petroleum hydrocarbons, grain size distribution, and percent solids. In addition, sediment samples from six locations adjacent to SA 57 downgradient of an historical fuel oil spill will be analyzed for volatile organic compounds (VOCs). Previous studies have not identified VOCs at concentrations of concern in Cold Spring Brook surface water or sediment, therefore analysis of VOCs will be limited to the vicinity of SA 57. Pesticides and PCBs have not been included as target analytes in previous samples collected from Cold Stream Brook downstream of the B&MRR right-of-way and no source in this area is suspected; however, because of the potential for low concentrations of these compounds to influence the interpretation of bioassay results, they are included as target analytes at the bioassay stations. The surface water samples will be analyzed in the field for pH, dissolved oxygen (DO), conductivity, and temperature.

3.3 MACROINVERTEBRATE COMMUNITY ANALYSIS

A qualitative macroinvertebrate study will be conducted at 10 surface water and sediment sampling locations along Cold Spring Brook (see Table 2). This study will be used to help evaluate potential effects associated with contaminant migration into aquatic habitats at Cold Spring Brook, as well as to attempt to document conditions in areas that the storm drain systems do not affect. This study will help to: (1) characterize benthic fauna, (2) determine whether the benthic communities are grossly impaired (relative to upstream areas along Cold Spring Brook), (3) identify source areas responsible for any observed impairment, and, (4) evaluate remedial action success.

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3.3.1 Field Methods

Information regarding the physical attributes of the aquatic habitat (including nature of the substrate and vegetative characteristics) and water quality parameters (e.g., pH, DO, conductivity,, and temperature) will be collected at each study location (as discussed above). In addition, a qualitative habitat assessment will be conducted at each station. Habitat Assessment Field Data Sheets will be completed for each sampling station.

Although the Cold Spring Brook Landfill (a Group 1A site) is located upstream of the proposed study area, available data suggest that relatively uncontaminated stretches of stream are located downgradient of Cold Spring Brook Landfill and upgradient of the proposed study area (ADL, 1994). Therefore, an upstream reference station will be identified in this region.

Stream macroinvertebrates in Cold Spring Brook will be sampled using D-frame aquatic dip nets and a grab sampler. One dip net sweep will be taken in as many different habitats as possible at a particular sampling location (e.g. under overhanging vegetation and logs, along stream banks, in both riffle and run areas, and in pools). A grab sampler such as an Ekman or Ponar dredge will also be used to collect representative macroinvertebrates at each Cold Spring Brook biological location.

Biological samples will be processed initially according to the methodology specified in the Rapid Bioassessment Protocol (RBP) guidance manual (Plafkin et al., 1989). A 100-organism subsample will be taken for those samples containing more than 100 organisms. This sample size is generally adequate to discriminate between impacted and non-impacted sites (Plafkin et al., 1989). Benthic organisms in the subsample will be identified to the family level, enumerated, and recorded on standardized data sheets. All samples will be archived in formalin for future evaluation, if needed.

Each identified organism will be assigned to a Functional Feeding Group classification.

3.3.2 Data Analysis Techniques/Metrics

A qualitative evaluation of the macroinvertebrate samples from the 10 stations will be conducted. Depending upon the results of this evaluation, as well as the results of the laboratory bioassay tests, family level identification of the 10

samples will be undertaken. Family level identification will focus on the samples collected in the vicinity of SA 57, and on the samples collected at stations with demonstrated laboratory bioassay toxicity.

Once taxonomic analysis of archived samples is completed, data evaluation may include calculation of simple metrics related to abundance, diversity, and community structure, as well as a review of percentages of pollution tolerant and sensitive organisms per sample. This evaluation will be less rigorous and more qualitative than the standard RPB II approach.

3.4 TOXICITY TESTING

A phased laboratory bioassay program is proposed to assess the toxicity of sediments to aquatic organisms residing within the sediments. Information derived from the proposed bioassays in Cold Spring Brook will be used to establish baseline conditions as well as to help evaluate effects from the storm drains or other potential non-point sources.

Although the results of the proposed sediment toxicity tests will be used to predict the effects that might occur to aquatic ecological receptors *in situ*, it is important to recognize that: (1) exposure to contaminated sediments might be avoided by motile organisms; and, (2) toxicity to organisms *in situ* may be dependent upon sediment physical characteristics and equilibrium partitioning that are not duplicable under laboratory conditions (ASTM, 1993).

3.4.1 Phase I: Screening Level Bioassays

The objective of the Phase I screening level bioassays is to obtain laboratory data to evaluate adverse effects associated with exposure of the freshwater invertebrate species *Chironomus tentans* and *Hyaella azteca* to whole sediment. Ten short-term chronic toxicity tests with *C. tentans* are proposed to provide screening level sediment toxicity data for Cold Spring Brook. Endpoints to be evaluated in the proposed short-term chronic test include survival, growth, percent emergence, and reproduction. Ten sediment samples for screening level bioassay will be collected concurrently and from the same locations as the sediment samples collected for analytical chemical analyses.

Larvae of the chironomid midge (*Chironomus tentans*) are frequently used in sediment toxicity testing because they are relatively large, are easily cultured

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under laboratory conditions, have a short generation time, and they have direct contact with sediment (ASTM, 1993). *C. tentans* are sensitive to many contaminants associated with sediments. Midge larvae are important dietary components of fish and surface-feeding ducks, and play an important role in sediment contaminant cycling. *C. tentans* burrow into mud-bottom littoral habitats in eutrophic lakes, ponds, and streams and build a protective case; this exposure to sediments makes them a reasonable test species to evaluate benthic communities in Cold Spring Brook. The proposed 10-day *C. tentans* study will evaluate survival of *C. tentans* larvae.

To provide additional characterization of potential sediment toxicity, the Army will perform 10-day survival tests using *Hyalella azteca*, an amphipod, in accordance with guidance provided by the U.S. Environmental Protection Agency (USEPA) in the draft document *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates* (USEPA, 1994). *H. azteca* is an epibenthic detritivore that burrows near the sediment surface and ingests sediment particles. The proposed *H. azteca* bioassays will be conducted with sediment from the same sampling stations as the other bioassays.

As discussed in Subsection 1.3, many of the target compounds in sediments at Cold Spring Brook are SVOCs, primarily polynuclear aromatic hydrocarbons (PAHs). The toxicity tests may therefore consider photoperiod, so as to account for the presence of photoactive or photolytic PAHs. PAHs have a low aqueous solubility, are hydrophobic, and are readily adsorbed on suspended organic and inorganic particles which settle and accumulate in the bottom sediments. Once deposited on the bottom, PAHs are less subject to photochemical, chemical, or biological degradation than they are in the water column, and are generally stable and persistent in the oxygen- and light-poor bottom sediments of water bodies. In the aqueous phase, sensitivity to direct photolysis increases with increasing PAH molecular weight. Thus, naphthalene is relatively insensitive to photolysis and benzo(a)pyrene is relatively sensitive. Linear PAHs such as anthracene and naphthalene are more sensitive than angular or condensed PAHs such as phenanthrene and chrysene. Sorption on bottom sediments decreases photolysis rate further, particularly for higher molecular weight PAHs (Rand and Petrocelli, 1985).

Following statistical analysis, the survival of *C. tentans* and *H. azteca* will be compared with survival of control organisms to assess the toxicity of sediments to these organisms.

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If the results of the Phase I bioassay program indicate that minimal sediment toxicity exists in Cold Spring Brook (i.e., if little or no statistically significant toxicity to either test organism is observed following subchronic exposure to whole sediment samples), no further bioassay studies are proposed. However, if the results indicate that exposure to certain sediment samples results in significant effects on the growth, reproduction, or survival of test species, then Phase II toxicity testing is proposed.

3.4.2 Phase II: Whole Sediment Dilution Series Bioassays

Based upon a preliminary analysis of the results of the Phase I bioassay program at Cold Spring Brook, a limited dilution series bioassay study may be conducted using a subset of sediment samples from the original collected samples. The dilution experiments will be used to calculate no observed effect concentrations (NOECs) and lowest observed effect concentrations (LOECs) (and if necessary the median lethal concentration [LC_{50}]) to the test species evaluated in the Phase I investigation (i.e., *H. azteca* and *C. tentans*). The dilution series will use whole sediment from the selected stations diluted with a range of reference sediment from an uncontaminated portion of Cold Spring Brook. Potential sediment dilutions include 100%; 50%; 25%; 12.5%; and, 6.25%; however, the lower range of dilutions may not be required if NOECs and LOECs are determined at the higher end of the range. The reference sediment will be defined as Cold Spring Brook sediment with no demonstrated toxicity, as determined in the Phase I screening level bioassay.

Following statistical analysis, survival of *C. tentans* and *H. azteca* survival will be compared with survival of control organisms to assess the toxicity of whole sediment.

The results of the sediment dilution series may be used to help establish PRGs for Cold Spring Brook sediment; if possible, a dose-response curve will be developed to facilitate setting of PRGs.

SECTION 3

3.5 INTERPRETATION AND ANALYSIS

A comprehensive evaluation of the data collected for the Cold Spring Brook SI will be presented and interpreted in a summary report. The report will include a description of field methods employed and will present, summarize, and evaluate the relevant background information and field and laboratory data. The report will also include recommendations for any further action at the site. A draft version of the report will be prepared and submitted for regulatory review. The final version of the report will incorporate review comments provided by the regulators and be issued concurrent with a formal comment response package.

4.0 PROJECT MANAGEMENT

Rationale for project organization and resource allocation are discussed in the POP. QA/QC procedures and responsibilities for ABB-ES, USAEC, and laboratory personnel are also described in the POP.

4.1 PROJECT MANAGEMENT

The duties, functions, and responsibilities associated with project management are detailed in the following paragraphs.

Program Manager. The Program Manager for ABB-ES' USAEC efforts is Mr. Joseph T. Cuccaro. He is responsible for providing direction, coordination, and continuous monitoring and review of the program. His responsibilities include initiating program activities; participating in work plan preparation; coordinating staff assignments; assisting in the identification and fulfillment of equipment and special resource needs; monitoring all task activities to confirm compliance with schedule, fiscal, and technical objectives; maintaining communications both internally and with the USAEC Contracting Officer's Representative (COR) through continuous interaction, thereby allowing quick resolution of potential problems; providing final review and approval of work plans, task deliverables, schedules, contract changes, and manpower allocations; and developing coordination among management, field teams, and support personnel to maintain consistency of performance.

Project Manager. The Project Manager for ABB-ES' Fort Devens efforts, Mr. Paul Exner, P.E., has the day-to-day responsibility for conducting the Fort Devens project. The Project Manager is responsible for confirming the appropriateness and adequacy of the technical or engineering services provided for a specific task; developing the technical approach and level of effort required to address each element of a task; supervising day-to-day conduct of the work, including integrating the efforts of all supporting disciplines and subcontractors for all tasks; overseeing the preparation of all reports and plans; providing for QC and quality review during performance of the work; confirming technical integrity, clarity, and usefulness of task work products; forming a task group with expertise in disciplines appropriate to accomplish the work; reviewing and approving sampling tests and QA plans, which include monitoring site locations, analysis methods to be used, and hydrologic and geophysical techniques to be used; developing and

SECTION 4

monitoring task schedules; supervising task fiscal requirements (e.g., funds management for labor and materials), and reviewing and approving all invoicing actions; and providing day-to-day communication, both within the ABB-ES team and with the USAEC COR, on all task matters including task status reporting.

Corporate Officer. ABB-ES' Corporate Officer, William R. Fisher, P.E., is responsible for ensuring that a contract for the services to be provided has been executed; necessary corporate resources are committed to conduct the program activities; corporate level input and response is readily available to both the ABB-ES team and the USAEC COR; and assistance is provided to the Program and Project Managers for project implementation.

Technical Director and Project Review Committee. The members of the Project Review Committee for this Task Order are Mr. James Buss; Mr. Michael Murphy; and Mr. Jeffrey Brandow. Mr. Buss will serve as Technical Director and will be responsible for the overall technical quality of the work performed. He also will serve as chairman of the review committee. The function of this group of senior technical and/or management personnel is to provide guidance and oversight on the technical aspects of the project. This is accomplished through periodic reviews of the services provided to confirm that they represent the accumulated experience of the firm, are being produced in accordance with corporate policy, and live up to the objectives of the program as established by ABB-ES and USAEC.

Quality Assurance Supervisor. Mr. Christian Ricardi is the QA Supervisor for ABB-ES' USAEC program and this project. The QA function has been established so that appropriate protocols from USAEC, Commonwealth of Massachusetts, and USEPA Region 1 are followed. In addition, the QA Supervisor must confirm that QC plans are in place and implemented for each element of the task. The QA Supervisor reports directly to the Program Manager, but is responsible to the Project Manager in matters related to management of the QA/QC work element. The QA Supervisor is independent of the Project Manager relative to corrective action. The QA Supervisor has authority to stop work that is not in compliance with the POP, provided he has the concurrence of the USAEC Geology and Chemistry Branch, the Program Manager, the COR, and the Contracting Officer.

Health and Safety Supervisor. Ms. Cynthia E. Sundquist is the Health and Safety Supervisor for the Fort Devens project, reporting directly to the Project Manager. She has stop work authority to prevent or mitigate any unacceptable health and

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safety risks to project personnel, the general public, or the environment. Responsibilities of this position include confirming that the project team and, in particular, field personnel, comply with the ABB-ES HASP; helping the Program Manager and Project Manager develop the site-specific HASP; making certain that the HASP is distributed to appropriate personnel; and informing the Program Manager and the appropriate USAEC personnel in the specified manner when any health- or safety-related incident occurs.

Contract Manager. Ms. Elaine H. Findlay is the Contract Manager for the Fort Devens effort. The Contract Manager supports the Program Manager and Project Manager in all contractual matters, providing a liaison between contract representatives for USAEC and all subcontracted services.

Project Administrator. Ms. Tina Clark is the Project Administrator for the Fort Devens effort. The Project Administrator supports the Program Manager and Project Manager in the day-to-day monitoring of fiscal, schedule, and documentation requirements. She is responsible for maintaining the necessary systems to support budget monitoring and controls, and schedule monitoring and maintenance; and for controlling the flow and processing of documentation.

Task Leader. Mr. Stanley Reed will serve as Task Leader for the Cold Spring Brook investigation. As a Task Leader, he is responsible for planning all of ABB-ES' field investigation activities. He also is responsible for the interpretation of all chemical and hydrogeologic information and data for the preparation of the report summarizing the results of this study.

Field Operations Leader. Mr. John Bleiler will serve as the Field Operations Leader for the Fort Devens Field Program. As Field Operations Leader he is responsible for conducting the field program in accordance with procedures outlined in the Work Plan and POP. He is also responsible for interpretation of all ecological characterization and bioassessment results for the preparation of the investigation report.

Laboratory/Data Management Leader. Mr. Tim Dame, as the coordinator of laboratory services, is responsible for implementing and maintaining the Fort Devens analytical program. His responsibilities as the Laboratory Management Leader will include coordination with the Project Manager, QA Supervisor, and the analytical subcontractor on overall project and individual site analytical efforts. As the Data Management Leader, Mr. Dame is responsible for operating

SECTION 4

and maintaining the database management systems committed to USAEC projects.

4.2 SUBCONTRACTORS

The following services and/or activities will be performed by subcontractors during the Cold Spring Brook field investigation activities: sediment bioassays, laboratory chemical analysis, and surveying.

Sediment Bioassay Services. Sediment bioassays will be subcontracted to a laboratory specializing in sediment toxicity testing.

Macroinvertebrate Taxonomic Evaluation. The identification of macroinvertebrates in Cold Spring Brook will be subcontracted to a laboratory specializing in this service.

Laboratory Chemical Analysis. The primary analytical laboratory for samples collected by ABB-ES at Fort Devens is Environmental Science & Engineering, Inc. (ESE) of Gainesville, Florida. ESE's analytical program is USAEC-approved.

Surveying Services. Surveying services will be subcontracted to a land surveying firm registered in the Commonwealth of Massachusetts.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services, Inc.
AREE	Area Requiring Environmental Evaluation
ASTM	American Society of Testing and Materials
B&MRR	Boston & Maine Railroad
COR	Contracting Officer's Representative
DO	dissolved oxygen
DQO	Data Quality Objective
ESE	Environmental Science and Engineering
FSP	Field Sampling Plan
HASP	Health and Safety Plan
LC ₅₀	median lethal concentration
LOEC	lowest observed effect concentration
NOEC	no observed effect concentration
PAH	Polynuclear Aromatic Hydrocarbon
PAL	Project Analyte List
PCB	polychlorinated biphenyl
POP	Project Operations Plan
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBP	Rapid Bioassessment Protocol
SA	Study Area
SI	Site Investigation
SVOC	semi-volatile organic compound
TOC	total organic carbon
TSS	total suspended solids

ABB Environmental Services, Inc.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

USAEC	U.S. Army Environmental Center
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

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Figure 1

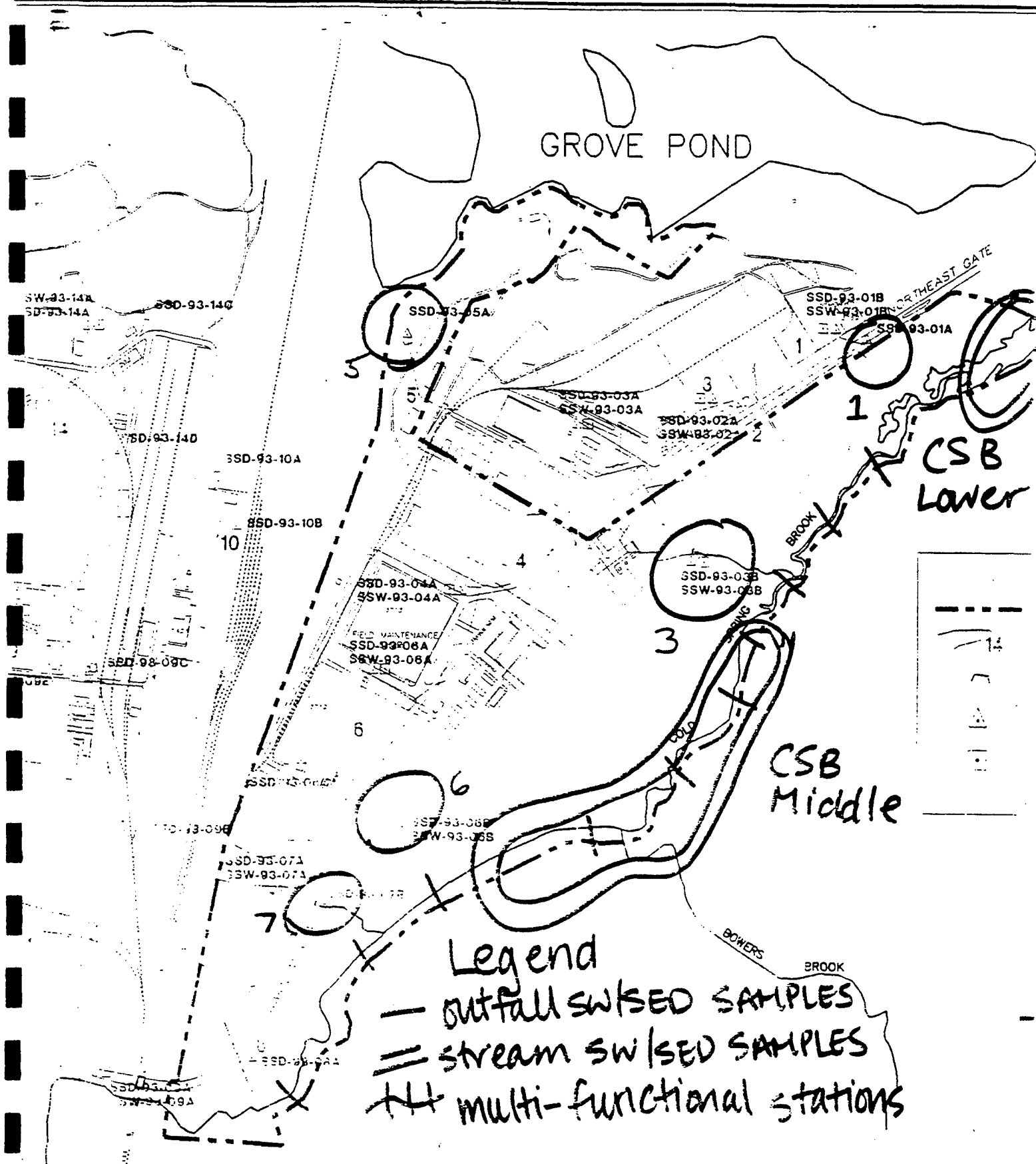
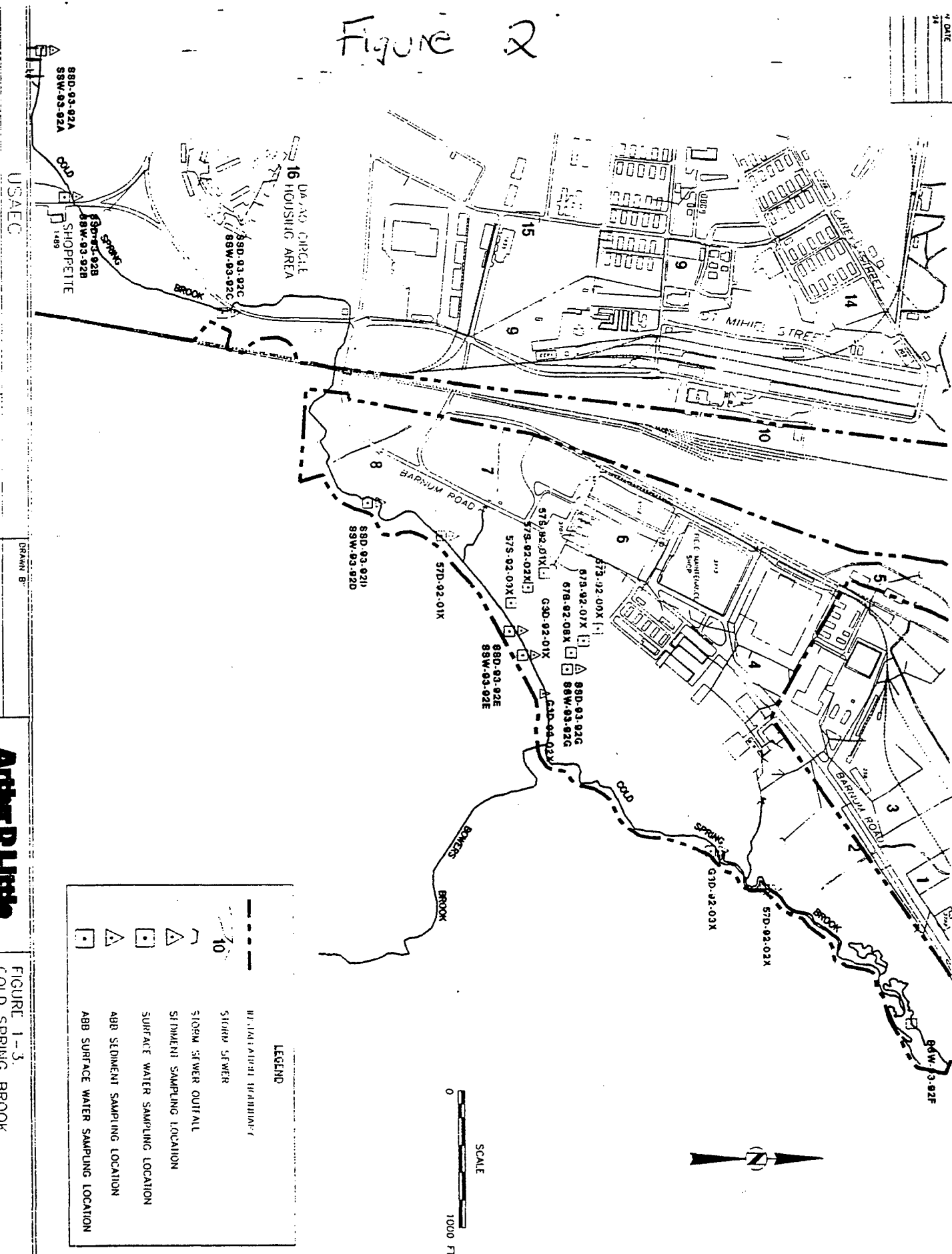


Figure 2



USAFEC

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Archer D Little

FIGURE 1--3

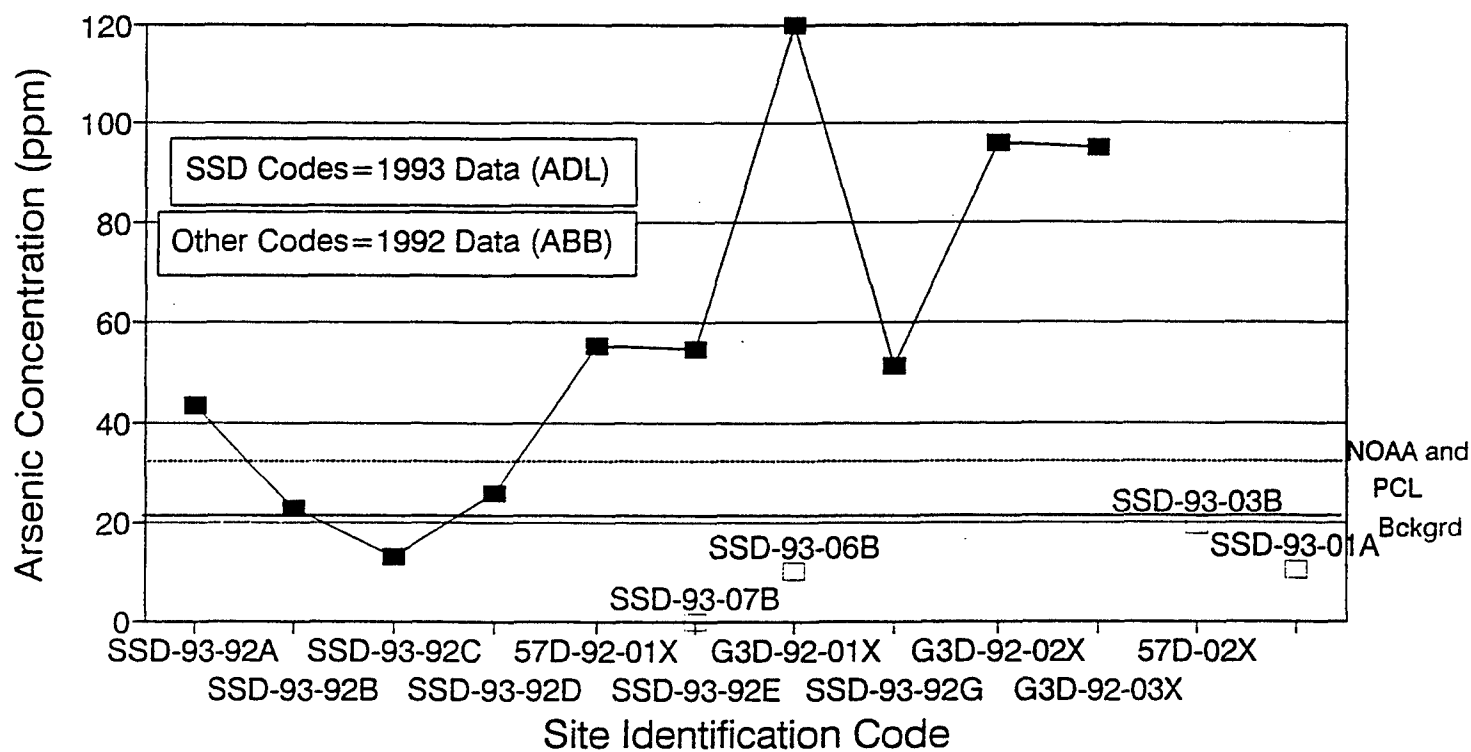
COLD SPRING BROOK

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PLIN CALL

Cold Spring Brook

Arsenic in Sediment



NOAA and PCL

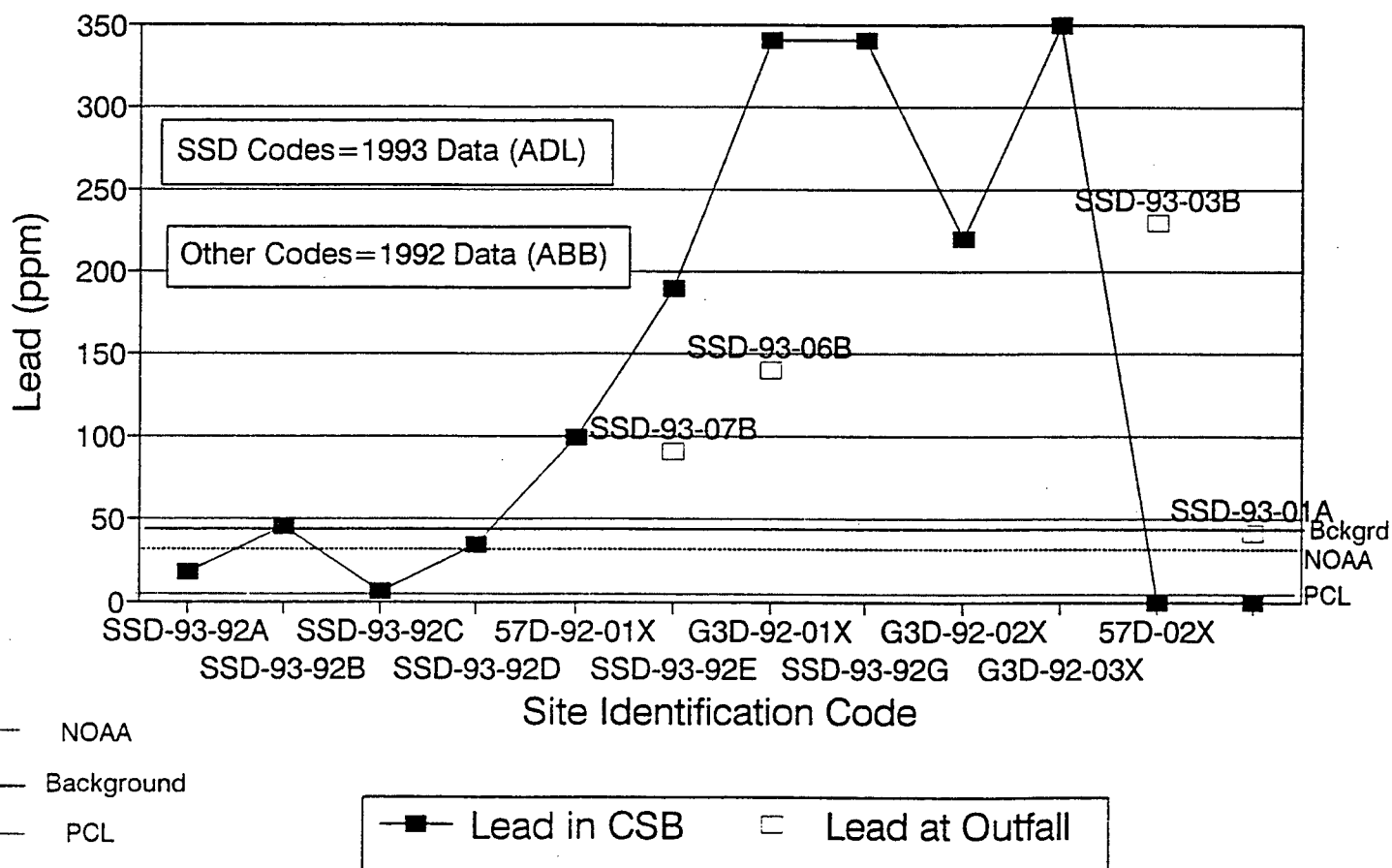
Background

—■— Arsenic in CSB

□ Arsenic at Outfall

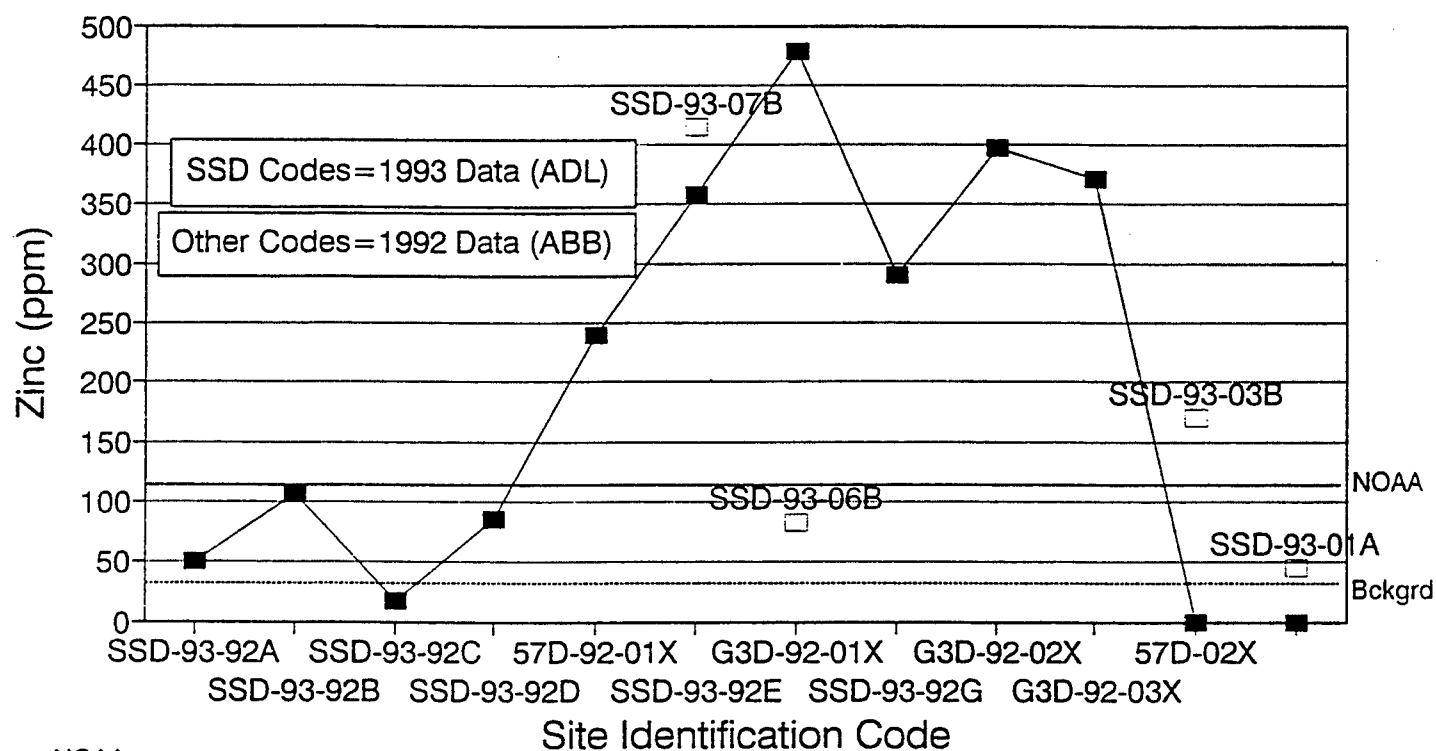
Cold Spring Brook

Lead in Sediment



Cold Spring Brook

Zinc in Sediment

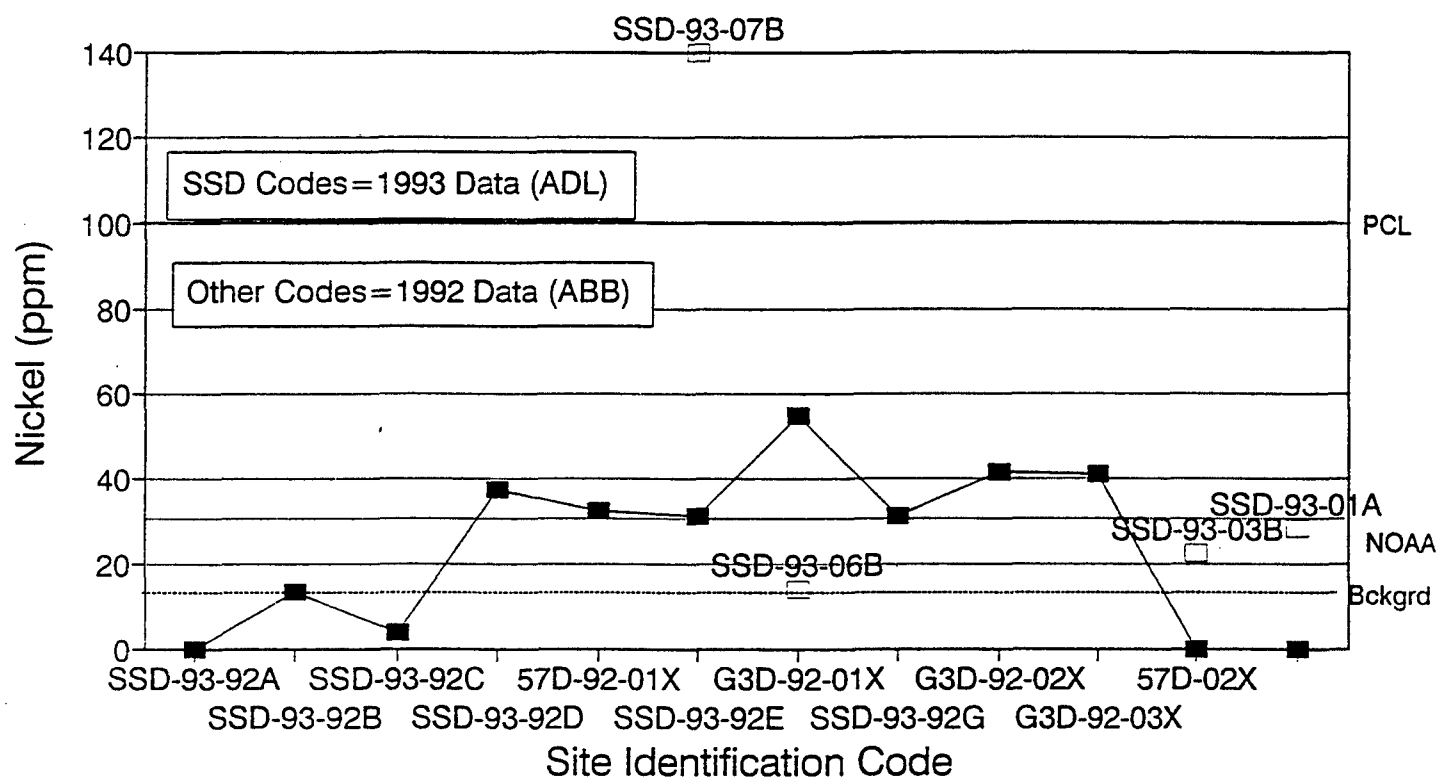


— NOAA
..... Background

■ Zinc in CSB □ Zinc at Outfall

Cold Spring Brook

Nickel in Sediment



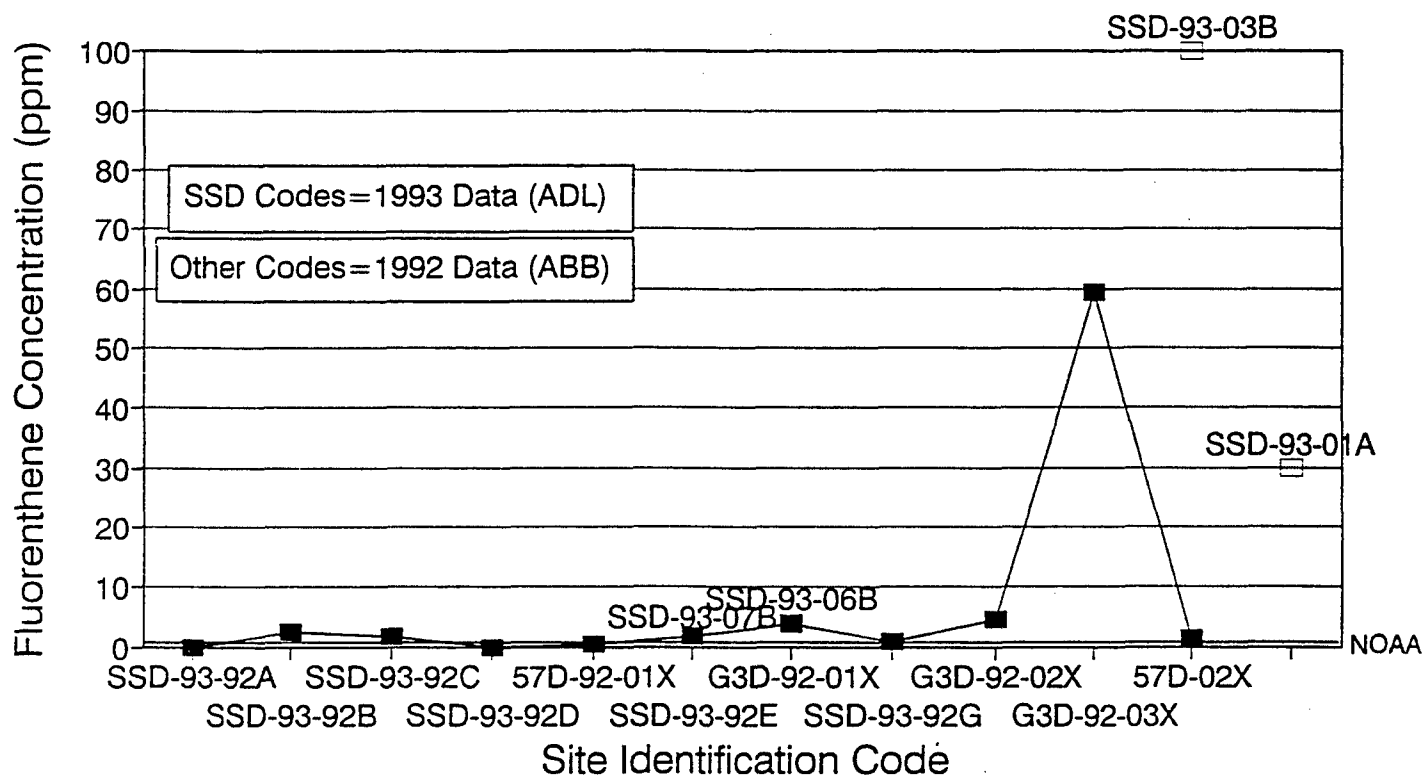
NOAA

Background

PCL

—■— Nickel in CSB = Nickel at Outfall

Cold Spring Brook Fluoranthene in Sediment



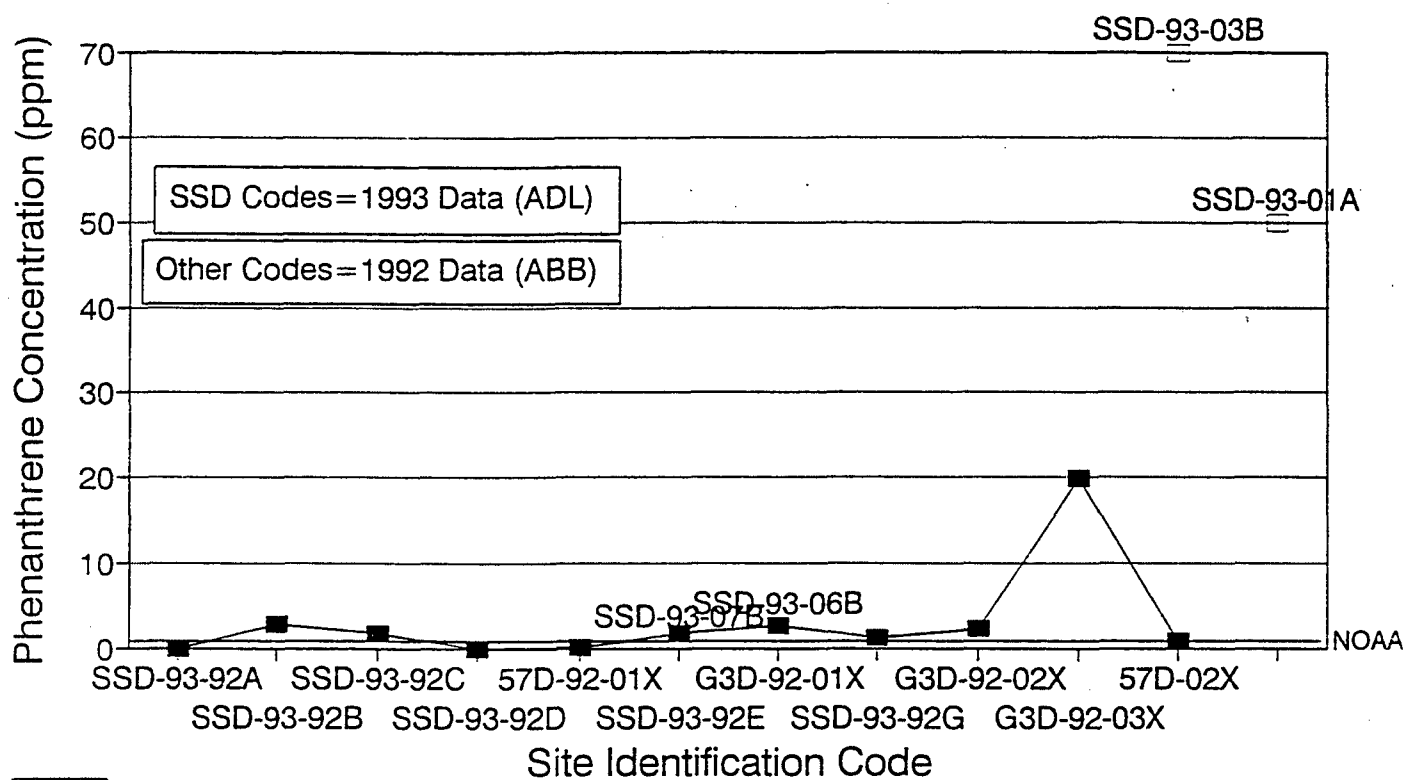
NOAA

*All levels of Fluoranthene fall below PCL Guidelines.

—■— In CSB = At Outfall

Cold Spring Brook

Phenanthrene in Sediment



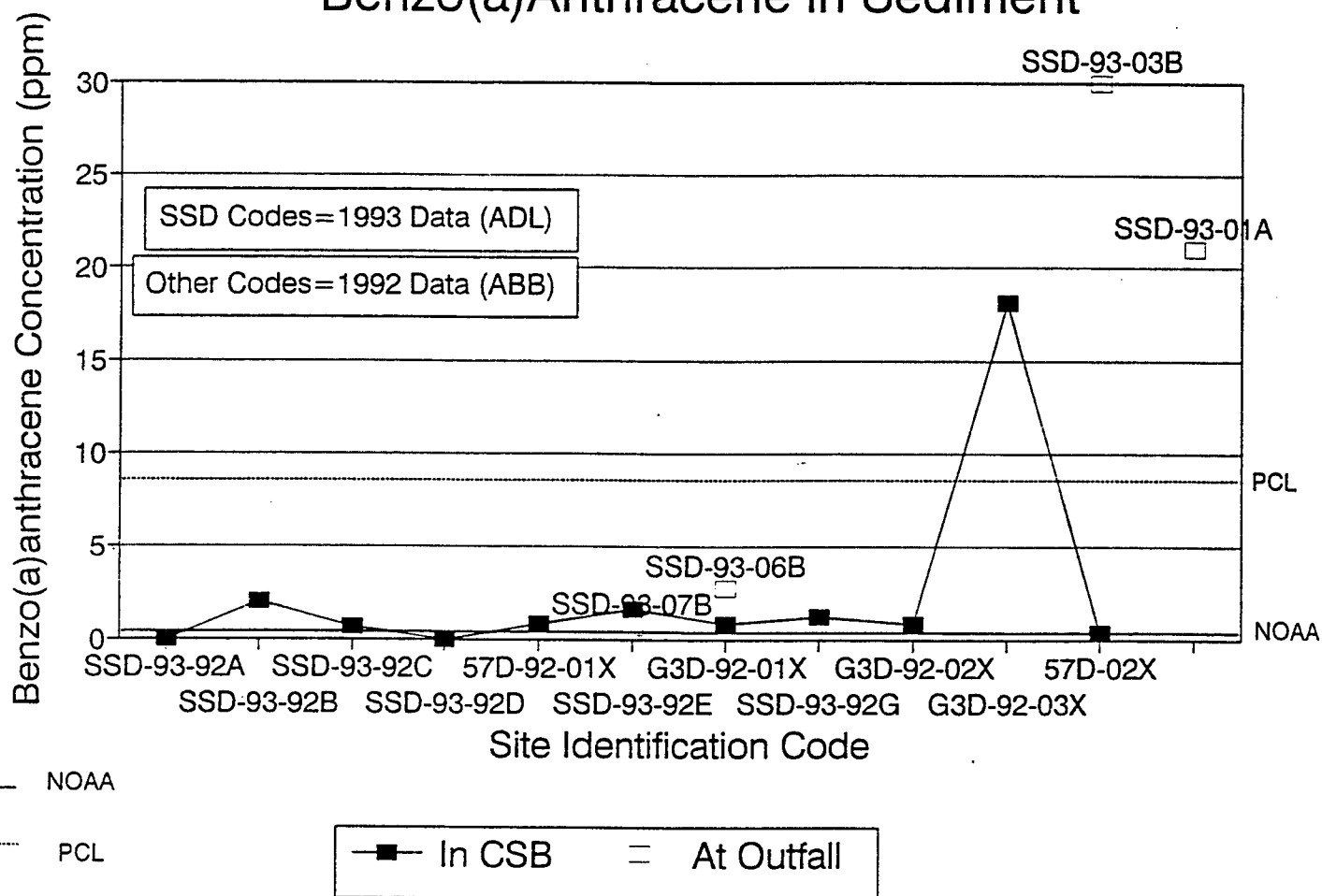
NOAA

* All Phenanthrene levels fall below PCL Guidelines.

—■— In CSB - - - □ - - - At Outfall

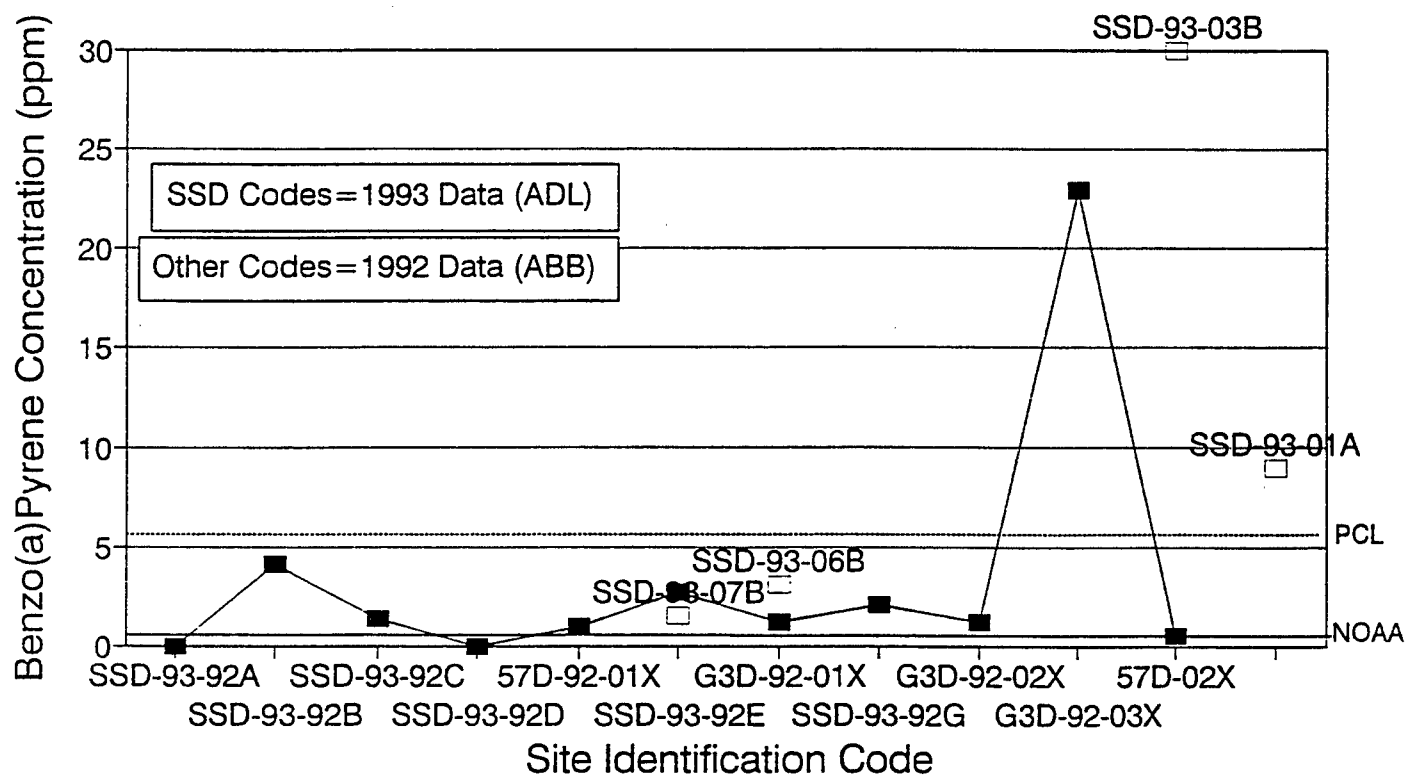
Cold Spring Brook

Benzo(a)Anthracene in Sediment



Cold Spring Brook

Benzo(a)Pyrene in Sediment



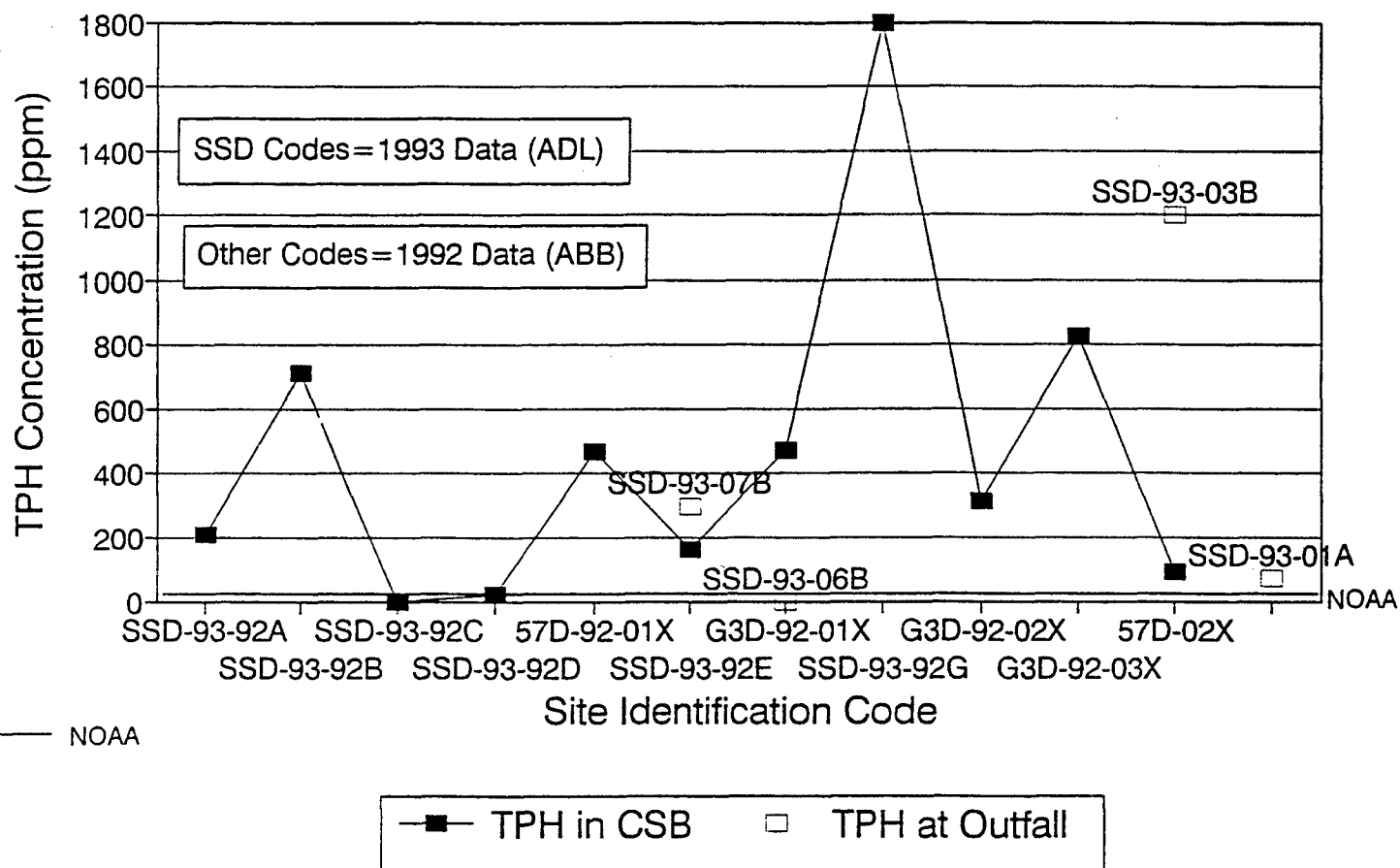
— NOAA

..... PCL

—■— Pyrene in CSB = Pyrene at Outfall

Cold Spring Brook

Total Petroleum Hydrocarbons



Outliers in Sediment:

System #1:

- 1) Anthracene: 9.7 ppm at SSD-93-01A
Range: 0-4.42
Highest at G3D-92-03X
NOAA: 0.085
PCL: 14000
- 2) Fluoranthene: 30 ppm at SSD-93-01A and SSD-93-01B
Range: 0-59.4
Highest at G3D-92-03X
NOAA: 0.6
PCL: 1100
- 3) Pyrene: 50 ppm at SSD-93-01A
Range: 0-53.1
Highest at G3D-92-03X
NOAA: 0.35
PCL: 550

System #2:

- 1) Fluoroanthene: 20 ppm at SSD-92-02A
Range: 0-59.4
Highest at G3D-92-03X
NOAA: 0.6
PCL: 1100
- 2) Pyrene: 30 ppm at SSD-92-02A
Range: 0-53.1
Highest at G3D-92-03X
NOAA: 0.35
PCL: 550

System #3:

- 1) Chromium: 70 ppm SSD-92-03A
Range: 6.24-50.7
Highest at G3D-92-01X
NOAA: 80
BACKGROUND: 31
PCL: 180
- 2) Vanadium: 63.3 ppm SSD-92-03A
Range: 11.9-72.5
Highest at G3D-92-03X
BACKGROUND: 28.7
PCL: 10
- 3) Perchloroethylene: 0.24 ppm at SSD-93-03B
Not detected in Cold Spring Brook
- 4) Anthracene: 20 ppm at SSD-92-03A
Range: 0-18.1
Highest at G3D-92-03X
NOAA: 0.085
PCL: 14000
- 5) Benzo(a)Anthracene: 60 ppm at SSD-92-03B
Range: 0-18.1
Highest at G3D-93-03X
NOAA: 0.23
PCL: 8.9

- 6) Benzo(a)Pyrene: 60 ppm at SSD-92-03B
Range: 0-22.9
Highest at G3D-92-03X
NOAA: 0.4
PCL: 5.5
- 7) Chrysene: 90 ppm at SSD-92-03B
Range: 0-47.1
Highest at G3D-92-03X
NOAA: 0.4
PCL: 440
- 8) Fluoranthene: 100 ppm at SSD-92-03B
Range: 0-59.4
Highest at G3D-92-03X
NOAA: 0.6
PCL: 1100
- 9) Pyrene: 200 ppm at SSD-92-03B
Range: 0-53.1
Highest at G3D-92-03X
NOAA: 0.35
PCL: 550
- Highest Concentration for following compounds:
- 1) 2-MethylPhenol: 0.35 ppm at SSD-92-03B
- 2) 4-Methylphenol: 2.2 ppm at SSD-92-03B
- 3) Benzo(b)Fluoranthene: 60 ppm at SSD-92-03B
Range: 0-32.7
Highest at G3D-92-03X
PCL: 180
- 4) Benzo(g,h,i)Perylene: 30 ppm at SSD-92-03B
PCL: 440
- 6) Benzo(k)Fluoranthene: 70 ppm at SSD-92-03B
Range: 0-33.2
Highest at G3D-92-03X
PCL: 320
- 7) Indeno(1,2,3-c,d)Pyrene: 19 ppm at SSD-93-03A
PCL: 320

System #5

- 1) Arsenic: 43 ppm at SSD-92-05A
Range: 13.1-120
Highest at G3D-92-01X
NOAA: 33
BACKGROUND: 21
PCL: 33
- 2) Beryllium: 1.62 ppm at SSD-92-05A
Range: 0-4.37
Highest at G3d-92-01X
BACKGROUND: 0.347
PCL: 0.88
- 3) Cobalt: 28.8 ppm at SSD-92-05A
Range: 0-29.8
Highest at G3D-92-01X
PCL: 50
- 4) Chromium: 163 ppm at SSD-92-05A
Range: 6.24-50.7

Highest at G3D-92-01X

NOAA: 80

BACKGROUND: 31

PCL: 180

5) Nickel: 82 ppm at SSD-92-05A

Range: 0-55.1

Highest at G3D-92-01X

NOAA: 30

BACKGROUND: 14

PCL: 100

6) Vanadium: 88.6 at SSD-92-05A

Range: 11.9-72.5

Highest at G3D-92-03X

BACKGROUND: 35.5

PCL: 640

7) Pyrene: 12 ppm at SSD-92-05A

Range: 0-53.1

Highest at G3D-92-03X

NOAA 0.35

PCL: 550

Highest concentration for following compounds:

1) Aluminum: 30400 ppm at SSD-92-05A

Range: 3080-20100

Highest at SSD-93-92G

BACKGROUND: 15000

PCL: 1700

2) Potassium: 5950 ppm at SSD-92-05A

Range: 0-3830

Highest at SSD-93-92D

BACKGROUND: 1700

3) Magnesium: 17500 ppm at SSD-92-05A

Range: 1070-11000

Highest at SSD-93-92D

BACKGROUND: 5600

System #6:

1) Arsenic: 52 ppm at SSD-92-06A

Range: 13.1-120

Highest at G3D-92-01X

NOAA: 33

BACKGROUND: 21

PCL: 33

2) Chromium: 64.6 at SSD-93-06B

Range: 6.24-50.7

Highest at G3D-92-01X

NOAA: 80

BACKGROUND: 31

PCL: 180

3) Lead: 420 ppm at SSD-93-06B

Range: 0-350

Highest at G3D-92-03X

NOAA: 35

BACKGROUND: 48.4

PCL: 4

Highest concentration for the following compound:

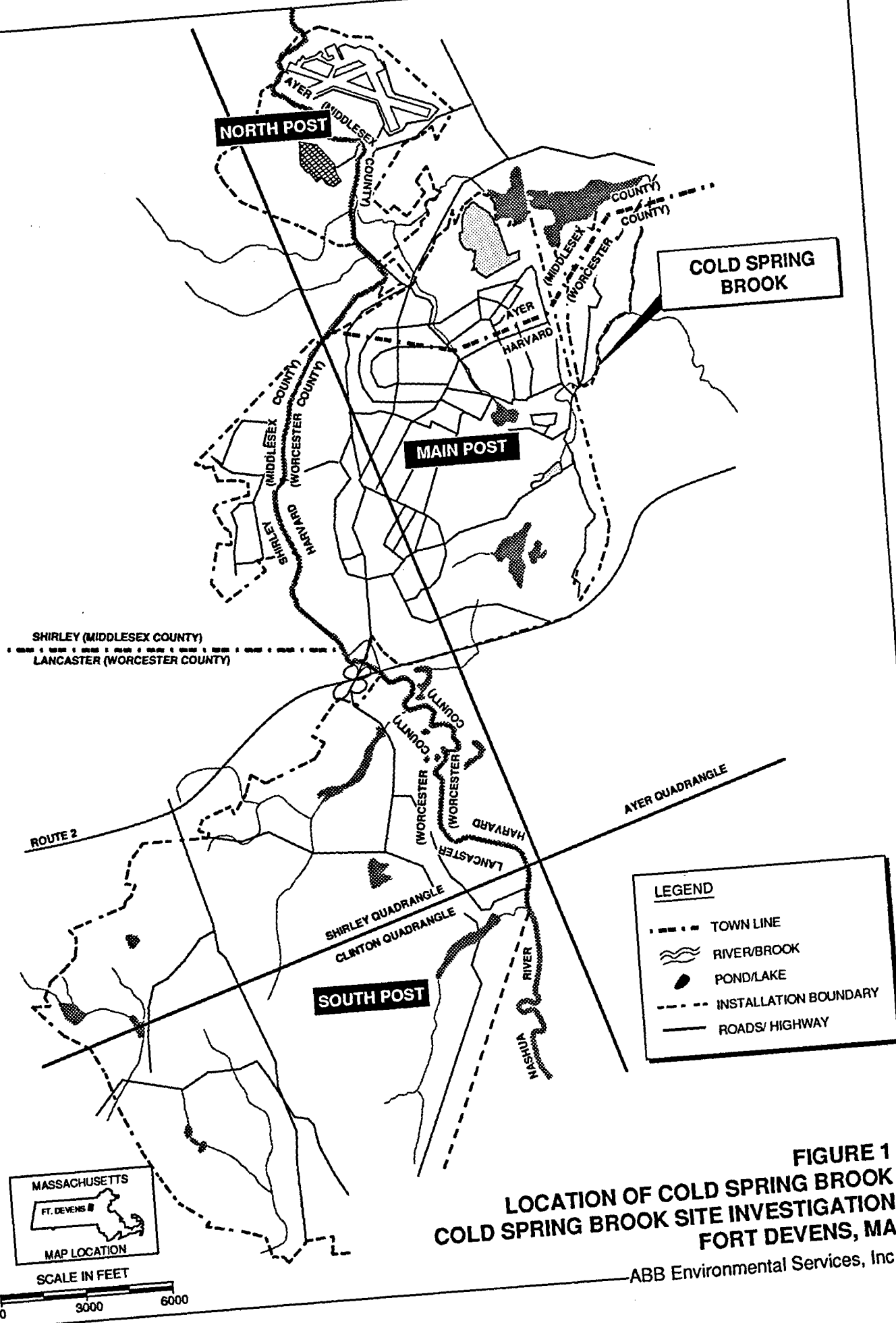
- 1) Tin: 13.5 ppm at SSD-92-06B

System #7:

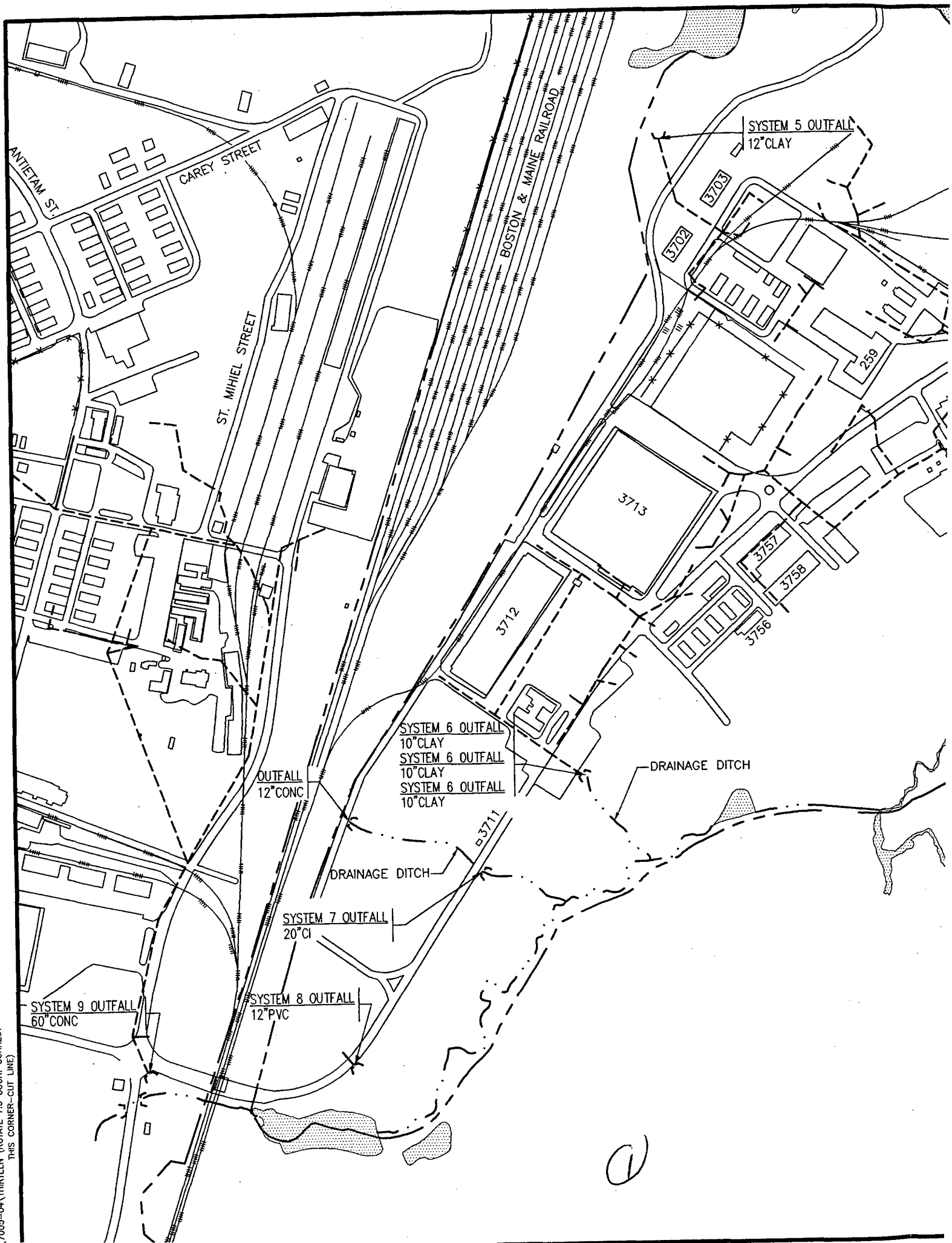
- 1) Arsenic: 41.6 ppm at SSD-92-07B
Range: 13.1-120
Highest at G3D-92-01X
NOAA: 33
BACKGROUND: 21
PCL: 33
- 2) Barium: 545 ppm at SSD-92-07B
Range: 7.85-188
Highest at G3d-92-02X
BACKGROUND: 42.5
PCL: 41
- 3) Beryllium: 8.35 ppm at SSD-92-07B
Range: 0-4.37
Highest at G3D-92-01X
BACKGROUND: 0.347
PCL: 0.88
- 4) Cobalt: 298 ppm at SSD-92-07B
Range: 0-29.8
Highest at G3D-92-01X
PCL: 50
- 5) Nickel: 140 ppm at SSD-92-07B
Range: 0-55.1
Highest at G3D-92-01X
NOAA: 30
BACKGROUND: 14
PCL: 100

Highest concentration for the following compounds:

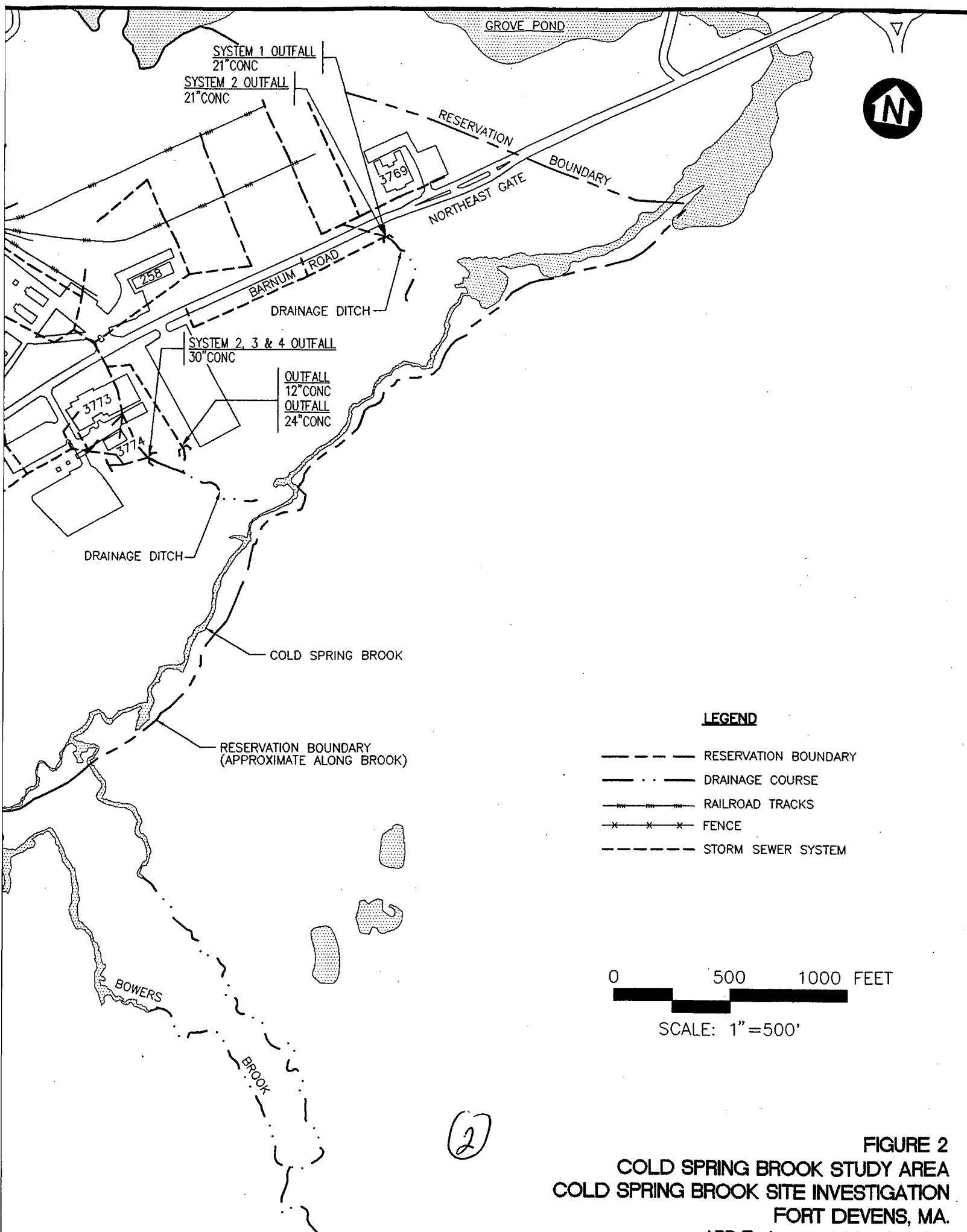
- 1) Manganese: 25000 ppm at SSD-92-07B
Range: 214-3150
Highest at G3D-92-02X
BACKGROUND: 300
PCL: 1500
- 2) Sodium: 455 at SSD-92-07B
Range: 0-2120
Highest at G3D-92-03X
BACKGROUND: 131

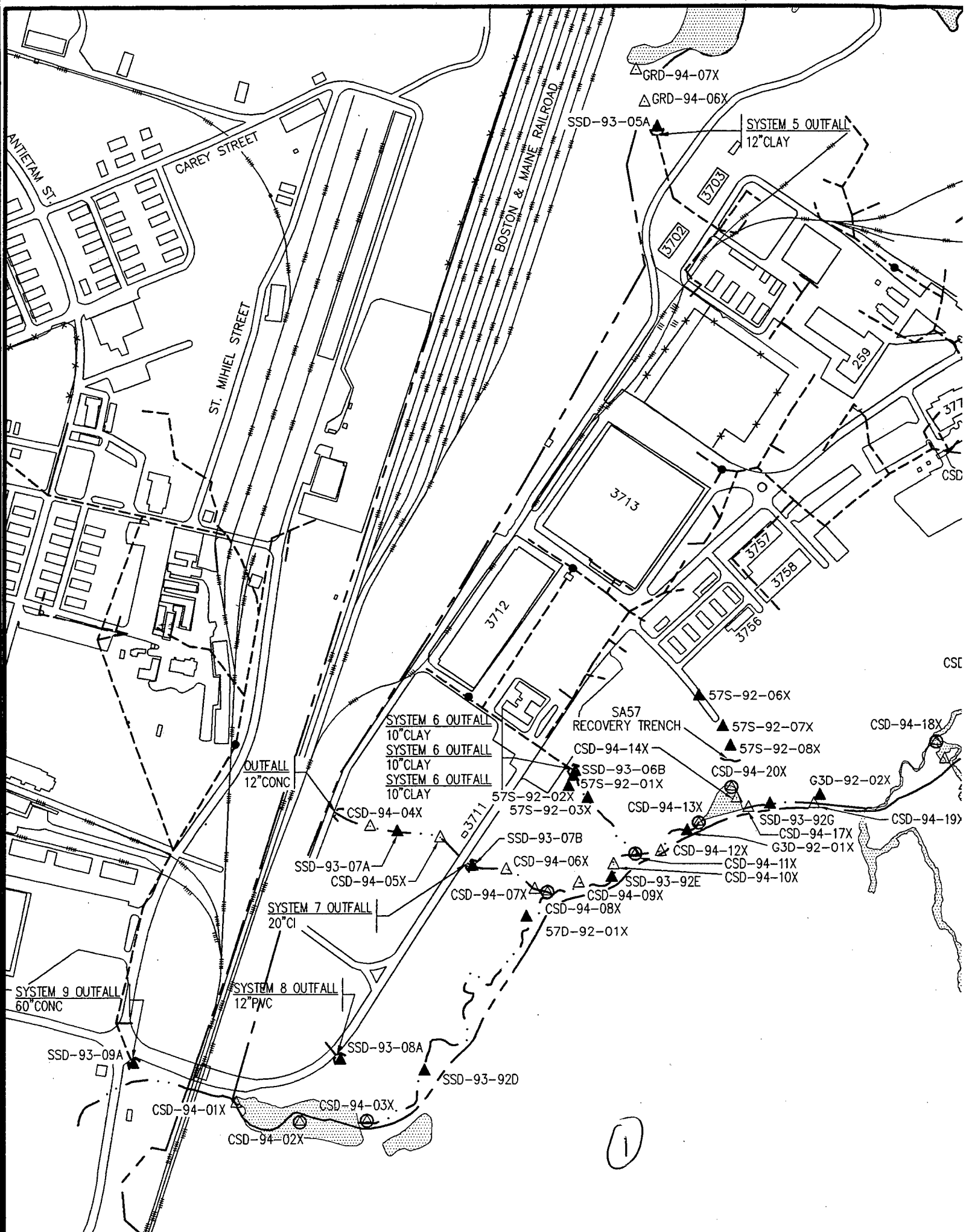


7005-04 THIRTEEN (ROTATE 7.5 DEGR. CORRECT THIS CORNER-CUT LINE)



①





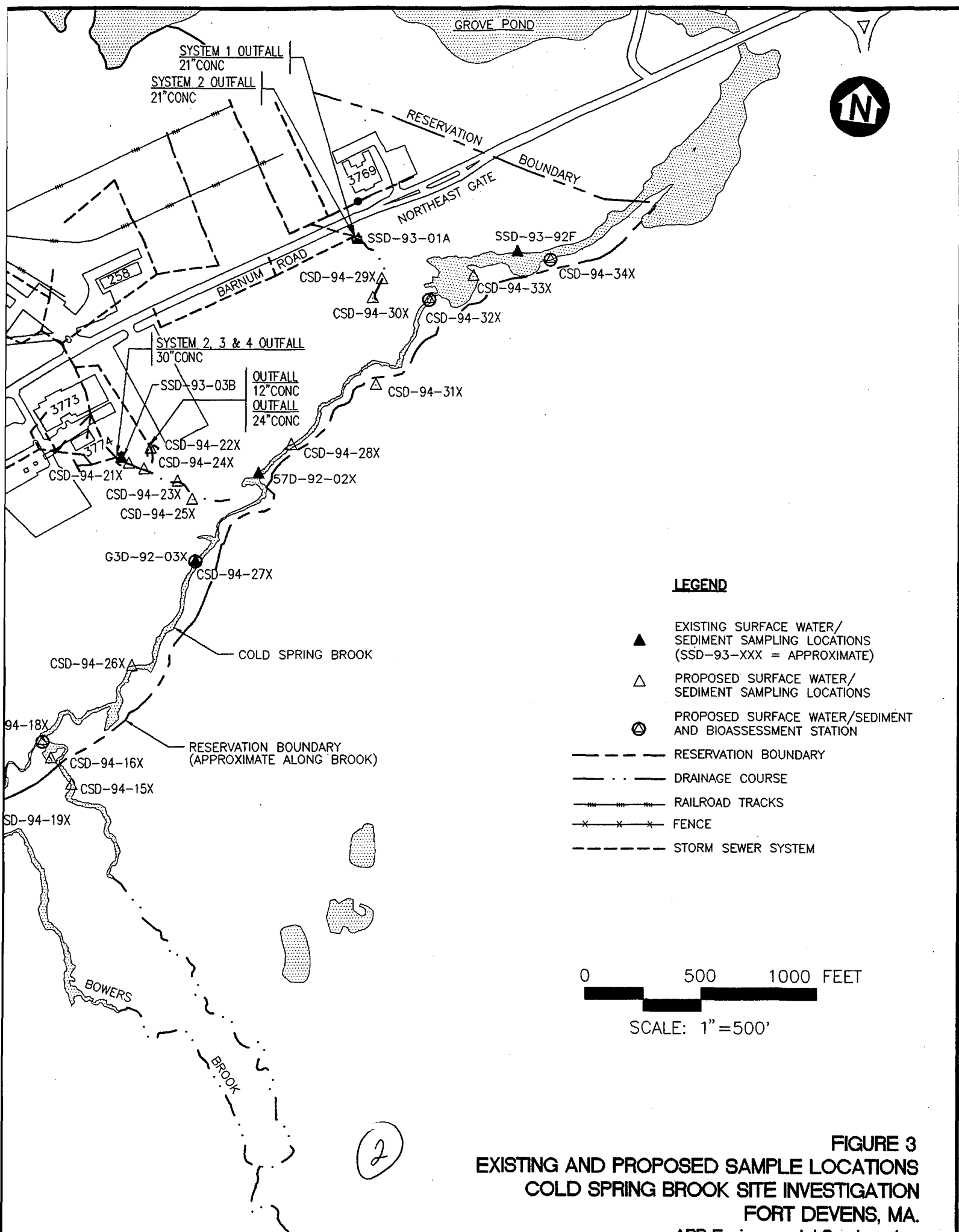


TABLE 1
SUMMARY OF PROPOSED SITE INVESTIGATION ACTIVITIES

COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ACTIVITY	STATIONS	TEST MEDIUM	ANALYSES	PURPOSE
Cold Spring Brook surface water and sediment evaluation	20	Bulk sediment and surface water	<p><u>Sediment</u> PAL SVOCs and inorganics, TOC, grain size distribution, percent solids. PAL VOCs at stations adjacent to SA 57, and pesticides/PCBs at bioassay stations.</p> <p><u>Surface water</u> PAL SVOCs and inorganics, water quality parameters, pH, DO, conductivity, temperature. PAL pesticides/PCBs at bioassay stations.</p>	Better define nature and extent of contamination in Cold Spring Brook and confirm established sources of contamination.
Storm System Outfall Surface Water and Sediment Evaluation (Systems No. 1, 3, 5, 6, & 7)	16	Bulk sediment and surface water	<p><u>Sediment</u> PAL SVOCs and inorganics, TOC, grain size distribution, percent solids. PAL pesticides/PCBs at bioassay stations.</p> <p><u>Surface water</u> PAL SVOCs and inorganics, water quality parameters, pH, DO, conductivity, temperature. PAL pesticides/PCBs at bioassay stations.</p>	Better understand the relationships between potential sources and contamination in Cold Spring Brook and the Cold Spring Brook floodplain.
Cold Spring Brook Sediment Toxicity Testing	10 of 20	Bulk sediment	Phase I sub-chronic <i>Chironomus tentans</i> and <i>Hyalella azteca</i> bioassays	Provide screening level toxicity testing of Cold Spring Brook sediment

continued

TABLE 1
SUMMARY OF PROPOSED SITE INVESTIGATION ACTIVITIES

COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

ACTIVITY	STATIONS	TEST MEDIUM	ANALYSES	PURPOSE
Toxicity Testing	2 or 3 of 20	Bulk sediment	Phase II dilution series sub-chronic <i>Chironomus tentans</i> and <i>Hyalella azteca</i> bioassays	Assist with the development of preliminary remedial goals.
MacroInvertebrate Study	10 of 20	Benthic macro-invertebrates	Evaluate community and population metrics via RBP II	Provide "weight of evidence" information regarding impacts to the macroinvertebrate community

Notes:

PAL = Project Analyte List
 SVOC = semivolatile organic compound
 TOC = total organic carbon
 VOC = volatile organic compound
 SA = Study Area
 PCB = polychlorinated biphenyl
 DO = dissolved oxygen

TABLE 2
SUMMARY OF PROPOSED SAMPLING STATIONS

COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

SOURCE	LOCATION ID	BIOASSESSMENT STATION ¹	LOCATION AND RATIONALE
Cold Spring Brook Upstream Reference Stations	CSD-94-01X CSD-94-02X	No Yes	Sample reference stations in upstream environment above dam to identify typical concentrations of analytes in lentic environments
	CSD-94-03X	Yes	Sample reference station in upstream environment below dam to identify typical concentrations of analytes in lotic environments
Storm Drain System No. 7	CSD-94-04X CSD-94-05X	No No	Sample drainage swale to identify contaminant contributions from west side of Barnum Road
	CSD-94-06X CSD-94-07X	No No	Sample drainage swale to identify contaminant contributions from east side of Barnum Road
	CSD-94-08X CSD-94-09X	Yes No	Sample in Cold Spring Brook downstream of drainage swale to evaluate impacts from System No. 7
Storm Drain System No. 6	CSD-94-10X	No	Sample end of System No. 6 drainage swale to provide complete sampling coverage to Cold Spring Brook
	CSD-94-11X CSD-94-12X	Yes No	Sample in Cold Spring Brook downstream of drainage swale to evaluate impacts from System No. 6
Study Area 57	CSD-94-13X CSD-94-14X CSD-94-17X CSD-94-19X CSD-94-20X	Yes No No No Yes	Sample Cold Spring Brook at Study Area 57 drainage swale in ponded area above dam (lentic area) and below dam
Bowers Brook	CSD-94-15X CSD-94-16X	No No	Sample Bowers Brook up- and downstream to identify contaminant contributions east of Cold Spring Brook
	CSD-94-18X	Yes	Sample Cold Spring Brook up- and downstream of Bowers Brook confluence to evaluate impacts from Bowers Brook
Storm Drain Systems No. 2/3/4	CSD-94-21X CSD-94-22X CSD-94-23X CSD-94-24X CSD-94-25X	No No No No No	Sample drainage swale to evaluate contributions from Systems No. 3 and 4

continued

TABLE 2
SUMMARY OF PROPOSED SAMPLING STATIONS

COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

SOURCE	LOCATION ID	BIOASSESSMENT STATION ¹	LOCATION AND RATIONALE
Storm Drain Systems No. 2/3/4	CSD-94-26X CSD-94-27X CSD-94-28X	No Yes No	Sample up-, at, and downstream of the confluence of Systems No. 3 and 4 drainage swale and Cold Spring Brook to evaluate impacts to the brook
Storm Drain Systems No. 1/2	CSD-94-29X CSD-94-30X	No No	Sample drainage swale to evaluate contributions from Systems No. 1 and 2
	CSD-94-31X CSD-94-32X CSD-94-33X	No Yes No	Sample up-, at, and downstream of the confluence of Systems No. 1 and 2 drainage swale and Cold Spring Brook to evaluate impacts to the brook
Cold Spring Brook Downstream Reference Station	CSD-94-34X	Yes	Sample recovery station in downstream environment to identify typical concentrations of contaminants moving offsite
Storm Drain System No. 5	GRD-94-06X GRD-94-07X	No No	Sample drainage swale to identify contaminant contributions to Grove Pond from west side of Barnum Road

Notes:

1. Bioassessment stations for laboratory toxicity testing and semi-quantitative macroinvertebrate sampling.

TABLE 3
SAMPLING AND LABORATORY ANALYSIS SCHEDULE

COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

FILE	SITE	MEDIA	SITE ID	SAMPLE ID	LABORATORY #	MS/ MSD	DUP	VOCs	SVOCs	PESTS/ PCBs	TOTAL METALS	DISS. METALS	TOC	TPH	WATER QUAL.	GRAIN SIZE DIST.	% SOLIDS
WATER SAMPLES																	
CSW STRM	Surface Water	CSW-94-01X	WXCS0100	DV1AW*	501			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-02X	WXCS0200	DV1AW*	502			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-03X	WXCS0300	DV1AW*	503			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-04X	WXCS0400	DV1AW*	504			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-05X	WXCS0500	DV1AW*	505			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-06X	WXCS0600	DV1AW*	506			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-07X	WXCS0700	DV1AW*	507			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-08X	WXCS0800	DV1AW*	508			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-09X	WXCS0900	DV1AW*	509			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-10X	WXCS1000	DV1AW*	510			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-11X	WXCS1100	DV1AW*	511			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-12X	WXCS1200	DV1AW*	512			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-13X	WXCS1300	DV1AW*	513			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-14X	WXCS1400	DV1AW*	514			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-15X	WXCS1500	DV1AW*	515			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-16X	WXCS1600	DV1AW*	516			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-17X	WXCS1700	DV1AW*	517			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-18X	WXCS1800	DV1AW*	518			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-19X	WXCS1900	DV1AW*	519			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-20X	WXCS2000	DV1AW*	520			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-21X	WXCS2100	DV1AW*	521			1		1	1	1			1		
CSW STRM	Surface Water	CSW-94-22X	WXCS2200	DV1AW*	522			1		1	1	1			1		

TABLE 3
SAMPLING AND LABORATORY ANALYSIS SCHEDULE

COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

FILE	SITE	MEDIA	SITE	SAMPLE	LABORATORY	MS/	DUP	VOCs	SVOCs	PCBs	TOTAL	DISS.	TOC	TPH	WATER	GRAIN
TYPE	TYPE		ID	ID	SAMPLE	#	MSD				METALS	METALS			QUAL.	SIZE
																DIST. SOLIDS
CSW	STRM	Surface Water	CSW-94-23X	WXCS2300	DV1AW*	523		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-24X	WXCS2400	DV1AW*	524		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-25X	WXCS2500	DV1AW*	525		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-26X	WXCS2600	DV1AW*	526		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-27X	WXCS2700	DV1AW*	527		1		1	1	1			1	1
CSW	STRM	Surface Water	CSW-94-28X	WXCS2800	DV1AW*	528		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-29X	WXCS2900	DV1AW*	529		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-30X	WXCS3000	DV1AW*	530		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-31X	WXCS3100	DV1AW*	531		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-32X	WXCS3200	DV1AW*	532		1		1	1	1			1	1
CSW	STRM	Surface Water	CSW-94-33X	WXCS3300	DV1AW*	533		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-34X	WXCS3400	DV1AW*	534		1		1	1	1			1	1
CSW	STRM	Surface Water	CSW-94-35X	WXCS3500	DV1AW*	535		1			1	1			1	1
CSW	STRM	Surface Water	CSW-94-36X	WXCS3500	DV1AW*	536		1			1	1			1	1

WATER SAMPLE SUBTOTAL

0	36	10	36	36	0	0	0	36	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	2	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0
0	2	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0
0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
0	42	14	42	42	0	0	0	0	0	0	0	0	0	0	0	0

Trip Blanks

Duplicates @ 5%

MS/MSD Samples @ 5%

Rinsate Blanks @ 5%

WATER SAMPLE TOTAL

TABLE 3
SAMPLING AND LABORATORY ANALYSIS SCHEDULE

COLD SPRING BROOK SITE INVESTIGATION
FORT DEVENS, MA

FILE	SITE	MEDIA	SITE	SAMPLE	LABORATORY	MS/	DUP	VOCs	SVOCs	PCBs	TOTAL	DISS.	TOC	TPH	WATER	GRAIN
TYPE	TYPE		ID	ID	SAMPLE	#	MSD	DUP			METALS	METALS			QUAL.	SIZE
																DIST. SOLIDS
SEDIMENT SAMPLES																
CSE STRM	Sediment		CSD-94-01X	DXCS0100	DV1AS*	537			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-02X	DXCS0200	DV1AS*	538			1	1	1		1	1	1	1
CSE STRM	Sediment		CSD-94-03X	DXCS0300	DV1AS*	539			1	1	1		1	1	1	1
CSE STRM	Sediment		CSD-94-04X	DXCS0400	DV1AS*	540			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-05X	DXCS0500	DV1AS*	541			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-06X	DXCS0600	DV1AS*	542			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-07X	DXCS0700	DV1AS*	543			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-08X	DXCS0800	DV1AS*	544			1	1	1		1	1	1	1
CSE STRM	Sediment		CSD-94-09X	DXCS0900	DV1AS*	545			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-10X	DXCS1000	DV1AS*	546			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-11X	DXCS1100	DV1AS*	547			1	1	1		1	1	1	1
CSE STRM	Sediment		CSD-94-12X	DXCS1200	DV1AS*	548			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-13X	DXCS1300	DV1AS*	549			1	1	1		1	1	1	1
CSE STRM	Sediment		CSD-94-14X	DXCS1400	DV1AS*	550			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-15X	DXCS1500	DV1AS*	551			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-16X	DXCS1600	DV1AS*	552			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-17X	DXCS1700	DV1AS*	553			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-18X	DXCS1800	DV1AS*	554			1	1	1		1	1	1	1
CSE STRM	Sediment		CSD-94-19X	DXCS1900	DV1AS*	555			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-20X	DXCS2000	DV1AS*	556			1	1	1		1	1	1	1
CSE STRM	Sediment		CSD-94-21X	DXCS2100	DV1AS*	557			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-22X	DXCS2200	DV1AS*	558			1		1		1	1	1	1
CSE STRM	Sediment		CSD-94-23X	DXCS2300	DV1AS*	559			1	1	1		1	1	1	1
CSE STRM	Sediment		CSD-94-24X	DXCS2400	DV1AS*	560			1		1		1	1	1	1

APPENDIX A

Follow on Evaluation of Lower Cold Spring Brook Storm Sewer Area

Follow on Evaluation of Lower Cold Spring Brook Storm Sewer Area

1. Introduction and Background

Lower Cold Spring Brook and associated storm sewer systems were evaluated in 1992 by Arthur D. Little Areas Requiring Environmental Evaluation (AREEs). The Lower Cold Spring Brook area receives from storm sewer systems that drain the locations in the Industrial (Barnum Road) area of Fort Devens.

Cold Spring Brook is a small brook that collects runoff from the northeastern area of the Main Post of Fort Devens. The brook drains a variety of land use areas. The southern section collects runoff from the magazine area and the Cold Spring Brook landfill. Further downstream, Cold Spring Brook flows north through woodlands and wetlands and collects runoff from the industrial area along Barnum Road. Storm drain systems #1 through #4, #6 through #9, #16 and #17 drain into Cold Spring Brook. In the Draft Storm Sewer System Evaluation (AREE 70) Report, systems 1, 2, 3, 5, 6, and 7 were identified as systems of concern based upon statistical evaluation of analytical results.

2. Storm Drain Systems

The Storm drain systems described below are shown on Figure 1.

System #1:

System #1 drains an area west of Building 3769 (the Armory) to the southeast and discharges from a headwall into a drainage swale, which discharges to Cold Spring Brook.

System #1 was determined to be occupied by a large rail yard from a 1943 aerial photograph. The area has been used for vehicle storage from 1952 to present. Currently the Massachusetts Army National Guard occupies the entire area.

System #2:

System #2 drains the east side of Barnum Road to the northeast and

Follow on Evaluation of Lower Cold Spring Brook Storm Sewer Area

discharges from the headwall into a drainage swale (the drainage swale is the same drainage swale that System #1 drains to). The westside of the system is connected to System #3. System #2 has drained a roadway (Barnum Road).

System #3:

System #3 drains an area around Building 259. The runoff is collected from around Building 259 and land to the west of Barnum Road (large lots are used for vehicle storage in this area). The runoff discharges through a headwall into a drainage swale that leads to Cold Spring Brook. This system also accepts flow from System #4.

Aerial photographs indicate that the site has been occupied by motor pools, vehicle repair shops and vehicle storage yards from 1943 to present. Presently the area is used for vehicle repair and storage.

System #4:

System #4 drains a large area southwest of Building 259. The system flows to the southwest meeting runoff collected from northern and eastern sides of Building 3713. The system flows under Barnum Road to the southeast, where it accumulates runoff from Buildings 3757 and 3758, and flows northeast into System #3.

Aerial photographs from 1942 indicate that the site has been used for vehicle maintenance and storage since then.

System #5:

System #5 drains the western section of the land occupied by the National Guard to the west of Barnum Road, near Buildings 3702 and 3703. The system accumulates runoff from paved areas around Buildings 3702 and 3703, flows northwest under the road leading to Grove Pond, and discharges into a wooded area on the southeast side of Grove Pond.

Aerial photographs from 1943 indicate the area was occupied by motor pools, vehicle repair shops, and vehicle storage yards. Presently, the area is

Follow on Evaluation of Lower Cold Spring Brook Storm Sewer Area

used for vehicle repair and general storage by the Massachusetts Army National Guard.

System #6:

System #6 collects runoff from the area around Buildings 3712 and 3713, an area that includes vehicle storage areas and a section of unpaved railroad track. The flow is initially southwest, passing under Barnum Road and discharges into a drainage swale that leads to Cold Spring Brook.

Aerial Photographs of the area include a commissary and vehicle storage maintenance facility. System #6 was determined to receive approximately 3,000 gallons of #4 fuel spilled from an overfilled underground storage tank in 1977. This fuel spill has been investigated as SA 57 during the Groups 2, 7 investigation. Currently the old commissary (Building 3712) is leased to the Boston Maine Railroad.

System #7:

System #7 drains a wooded area located south of System #6, flows to the east, and empties into a drainage swale that leads to Cold Spring Brook.

The land near System #7 includes a driver training facility to the northwest and railroad tracks to the west.

System #8:

System #8 drains a wooded area at the intersection of Barnum Road and Dakota Street, flows northwest to the southeast, crossing Barnum Road and continuing through a marsh area, and discharges into Cold Spring Brook.

The system is wooded to the east and contains railroad tracks and woodlands to the west.

3. Data Analysis and Conclusions:

The AREE 70 Report results and conclusions are tabulated in Appendix A

Follow on Evaluation of Lower Cold Spring Brook Storm Sewer Area

and are summarized below. Systems 1, 2, 3, 5, 6, and 7 were identified as "Systems of Concern" due to the occurrence of multiple statistical outlier for analytes detected in sediment and surface water samples taken from either system outfalls or intermediate locations within the system.

Storm Sewer Systems:

System #1:

System #1 had outliers for three semi-volatile organic compounds in sediment: anthracene, fluoranthene, and pyrene. It also showed outlier in water for copper and lead. No compounds were found as having the highest concentration of any analytes in the data set.

The presence of semi-volatile organic compounds in System #1 is consistent with the area's use for vehicle storage.

Systems #2 and #3:

Systems #2 and #3 are presented together because they are connected. System #2 indicated outlier for semi-volatile organic compounds in sediment for fluoranthene and pyrene. It also demonstrated an outlier in water for arsenic. The system contains no analytes of highest concentration.

System #3 had outlier for metals, volatile organic, and semi-volatile organic compounds in sediment as follows: chromium, perchloroethylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene. System #3 also had an outlier in water for lead. The system contains the highest concentration for the following compounds: 2-methylphenol, 4-methylphenol, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-c,d)pyrene.

The presence of metals and semi-volatile organic compounds in Systems #2 and #3 is consistent with historical land use, which includes vehicle repair shops and storage yards since 1943.

System #5:

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System #5 indicates outlier for metals and one semi-volatile organic compound in sediment for the following analytes: arsenic, beryllium, cobalt, chromium, nickel, and pyrene. The system also indicates the highest concentration for aluminum, potassium, and magnesium.

The presence of metals and semi-volatile organic compounds in System #5 is consistent with historical land use as motor pools, vehicle repair shops and vehicle storage yards since 1943.

System #6:

System #6 has several outlier of metals in sediment for the following analytes: arsenic, chromium, and lead. The system also exhibited outlier in water for arsenic and lead. The system contains the highest concentration in sediment for tin.

The presence of metals in System #6 is consistent with historical land use in the area drained by it, which includes use as a vehicle storage and maintenance facility. The presence of metals is consistent with railway and trucking operations in the drainage area. System #6 also carried the discharge from the UST overflow associated with the study area SA 57.

System #7:

System #7 has several outliers for several for metals in sediment for the following analytes: arsenic, barium, beryllium, cobalt, and nickel. The system also contains the highest concentration in sediment for the following compounds: manganese and sodium.

The metals observed in System #7 are not consistent with known historical land use in the area, which is predominantly open space, a driver training facility and railroad tracks.

Graphs:

Graphs for the following analytes were presented in the AREE 70 Report and are duplicated in this report: chromium, phenanthrene, arsenic,

Follow on Evaluation of Lower Cold Spring Brook Storm Sewer Area

benzo(a)anthracene, benzo(a)pyrene, fluoranthene, lead, nickel, zinc, and total petroleum hydrocarbons. Specific aspects of the graphs area as follows:

- * Upstream locations are to the left with downstream locations to the right.
- * Sample locations are shown on Figure 2.
- * The solid black lines with solid boxes indicate concentration levels on the stream.
- * The open boxes indicate concentration levels at the storm sewer outfalls.
- * The outfall sediment samples are indicate on the x-axis location corresponding to the next (closest) down stream sample from within Cold Spring Brook as follows:
 - * Systems #1 and #2 are associated with outfall sample location SSD-93-01A, with no corresponding down stream sample.
 - * Systems #3 and #4 are associated with outfall sample location SSD-93-03B, with sample 57D-92-02X corresponding to the closest down stream sample.
 - * System #6 is associated with outfall sample location SSD-93-06B, with sample G#D-92-01X corresponding to the closest down stream sample.
 - * System #7 is linked with outfall sample location SSD-93-07B, with sample SSD-93-92E corresponding
- * The industrial area is indicated by the sample locations from SSD-93-92D to 57D-92-02X (for sediment) and SSW-93-92D to SSW-93-92F (for surface water).
- * The graphs also indicate sediment guideline levels from NOAA

Follow on Evaluation of Lower Cold Spring Brook Storm Sewer Area

(effects range- low), The Protective Contaminant Level (PCL) calculated by ABB Environmental Services, Inc. and used in the Site Investigation Reports, and the calculated soil background concentration levels for Ft. Devens.

Results of the Graph:

The highest concentration of the following analytes were detected at the locations indicated:

	Stream	Conc.*	Outfall	Conc.*
Chromium	G3D-92-01X	50.7	SSD-93-01A	48
Phenanthrene	G3D-92-03X	19.8	SSD-93-03B	100
Arsenic	G3D-92-01X	120	SSD-93-03B	19.2
Benzo(a)Pyrene	G3D-92-03X	22.9	SSD-93-03B	30
Fluoranthene	G3D-92-03X	59.4	SSD-93-03B	100
Lead	G3D-92-03X	350	SSD-93-03B	230
Nickel	G3D-92-01X	55.1	SSD-93-01A	28.4
Zinc	G3D-92-01X	479	SSD-93-07B	415
Benzo(a)-anthracene	G3D-92-03X	18.1	SSD-93-03B	30
Total Petroleum Hydrocarbons	SSD-93-92G	1800	SSD-93-03B	1200

* concentrations in parts per million (ppm)

Conclusions

The graphs do not indicate that there is a clear correlation between most of the concentrations found in the outfalls and the concentrations found in the stream. With the exception of fluoranthene, benzo(a)pyrene, benzo(a)anthracene, phenanthrene, and possibly lead, there is no consistent indication of sediment samples collected from the stream locations closest to "elevated" outfall samples having "elevated" concentrations of the same compound. In the case of the PAHS indicated above, there does appear to be a possible correlation between the elevated PAH concentrations associated with outfall sample location SSD-93-03B and the stream sample location G3D-92-03X. This correlation is somewhat uncertain, as the stream sample appears to

Follow on Evaluation of Lower Cold Spring Brook Storm Sewer Area

be upstream of the outfall. However, exact drainage patterns in the area are difficult to verify and the stream sample may actually be at the confluence of the outfall tributary to the stream and the stream itself. In the case of lead, the trend is more general, with samples outfalls samples SSD-93-07B, SSD-93-06B, and SSD-93-03B showing a generally higher concentration, which is reflected in the stream samples from SSD-93-92E through G3D-92-03X. Again, the correlation is somewhat uncertain, as the outfall concentrations are well below the stream concentrations, which is the opposite of what would be expected if the outfalls were the primary source of lead in Cold Spring Brook.

With exception of the possible correlations described above, based upon the available data, there is no clear indication that the outfalls are the single, or even the primary source of the contamination detected in Cold Spring Brook. There is a general trend in all analytes in Cold Spring Brook that they increase from sample location 57D-92-01X downstream, which corresponds to the general location of the Fort Devens industrial area. However, based upon the existing data, the storm sewer systems do not appear to be acting solely as a point sources for contamination in Cold Spring Brook. There appears to be additional, possible non-point sources contributing to the contamination in Cold Spring Brook none attributable to the storm sewer systems. Additionally, the extreme variability of natural geochemistry within the variable sediment areas sampled in Cold Spring Brook may also contribute to the data variability.

The below described proposed sampling plan is designed to establish/confirm the conceptual site model of both storm sewer and non-point source releases as well as determine the overall ecological impacts on Cold Spring Brook. Additional details will be provided in a forthcoming workplan.

4. Recommended Sampling

Description of Areas to be Sampled

Five outfall areas, Lower Cold Spring Brook, and Mid-Cold Spring Brook are recommended for further surface water and sediment sampling (Figure 1). Additionally, multi-functional ecological assessment stations are recommended to be set up along the stream.

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Sediment and Surface Water Sampling:

Surface water/sediment sample pairs will be collected from the above and below described areas to allow for evaluation of the nature and extent of contamination detected at storm sewer outfalls and to determine if contamination from within storm sewer systems is being carried downstream from outfalls. All surface water/sediment sample pairs will be analyzed for SVOCs, Metals, and TPH. Surface water samples will include analysis for filtered metals, Total Suspended Solids, and Water Quality Parameters. Sediment samples will include analysis for TOC and grain size. Sample collection will also include a detailed ecological and geological characterization of the sample location to correlate similar areas (floodplain, detritus, sand, etc.).

System #1 Outfall:

The outfall carries material that has been drained from an area west of Building 3769(the Armory) to the southeast. The presence of semi-volatile organic compounds are consistent with the area's use for vehicle storage. System #1 Outfall has the following analytes above the NOAA guidelines: Phenanthrene, Benzo(a)anthracene, Fluoranthene, Benzo(a)pyrene, lead and total petroleum hydrocarbons. The analytes above PCL guidelines are Phenanthrene, Benzo(a)pyrene, and lead. The analytes above the background guidelines are Zinc and Nickel. Surface water sediment sample pairs are recommended from the outfall area and downstream along the storm drain tributary. The purpose of the samples is to determine the nature and extent of contamination and to determine possible impacts on Cold Spring Brook.

System #3 Outfall:

The outfall carries material that has been drained from an area around building 259 and land to the west of Barnum Road. The presence of metals and semi-volatile organic compounds are consistent with historical land use, which includes vehicle repair shops and storage yards since 1943. It also carries material from System #2 where they are connected. System #3 Outfall has the following analytes above NOAA guidelines: Zinc, Phenanthrene, Benzo(a)anthracene, fluoranthene, Benzo(a)pyrene, lead, and total petroleum

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hydrocarbons. The analytes above PCL guidelines are Benzo(a)anthracene, Benzo(a)pyrene, and lead. Analytes above background guidelines are Zinc, Lead, and Nickel. Surface water sediment sample pairs are recommended from the outfall area and downstream along the tributary. The purpose of the samples is to determine the nature and extent of contamination and to determine possible impacts on Cold Spring Brook.

System #5 Outfall:

System #5 outfall collects material drained from the western section of the land occupied by the National Guard to the west of Barnum Road, near Buildings 3702 and 3703. The system also accumulates runoff from paved areas around Buildings 3702 and 3703. This runoff flows northeast under the road leading to Grove Pond and discharges into a wooded area on the southeast side of Grove Pond. The presence of metals and semi-volatile organic compounds is consistent with historical land use as motor pools, vehicle repair shops, and vehicle storage yards since 1943. Surface water sediment sample pairs are recommended from the outfall area and downstream along the storm drain tributary. The purpose of the samples is to determine the nature and extent of contamination and to determine possible impacts on Grove Pond.

System #6 Outfall:

System #6 outfall collects runoff from the area around Buildings 3712 and 3713. The presence of metals is consistent with historical land use which includes vehicle storage, maintenance facility, and railway and trucking operations. System #6 also carried the discharge from the UST overflow associated with study area SA-57. System #6 Outfall has the following analytes above NOAA guidelines: Phenanthrene, Benzo(a)anthracene, Fluoranthene, Benzo(a)pyrene, and Lead. The analyte above PCL guideline is lead. The analyte above background guidelines are Zinc, Lead, and Nickel. Surface water sediment sample pairs are recommended from the outfall area and downstream along the storm drain tributary. The purpose of the samples is to determine the nature and extent of contamination and to determine possible impacts on Cold Spring Brook.

System #7 Outfall:

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System #7 outfall collects material drained from a wooded area located south of System #6. The metals observed in System #7 are not consistent with known historical land use. System #7 Outfall has the following analytes above NOAA guidelines: Zinc, Benzo(a)anthracene, Fluoranthene, Benzo(a)pyrene, Lead, Nickel, and Total Petroleum Hydrocarbons. The analytes above PCL guidelines are Lead and Nickel. Analytes above background guidelines are Zinc, Lead, and Nickel. Surface water sediment sample pairs are recommended from the outfall area and downstream along the storm drain tributary. The purpose of the samples is to determine the nature and extent of contamination and to determine possible impacts on Cold Spring Brook.

Cold Spring Brook:

Stream surface water/sediment sample pairs in the Cold Spring Brook-Middle sample area to determine the nature and extent of contamination. Also, stream surface water/sediment sample pairs will be collected in the Cold Spring Brook-Lower sample area to test the nature and extent of contamination.

Multi-functional Ecological Assessment Stations:

Multi-functional ecological sample stations may be established along Cold Spring Brook. The first stations will be established upstream of the industrial area with subsequent stations extending downstream along Cold Spring Brook as it passes along the industrial area. At each station, surface water/sediment sample pairs shall be collected. Surface water/sediment sample pairs shall be analyzed for TPH, inorganics, SVOCs, and TOC. Surface water samples will include analysis for filtered metals, Total Suspended Solids, and Water Quality Parameters. Sediment samples will include analysis for TOC and grain size. Benthic macroinvertebrate samples may also be collected from stations and reviewed for taxonomy. The Benthic macroinvertebrate analysis may be performed to determine trends in population diversity and abundance the in lower Cold Spring Brook Area. Sediment toxicity bioassay samples will also be collected and analyzed.